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(54) Title: PYRONE ANALOG COMPOSITIONS AND METHODS

(57) Abstract: Novel pyrone analogs are described which can enhance the effectiveness of a therapeutic agent when administered and/or reduce side effects caused by the administration of a therapeutic agent.

PYRONE ANALOG COMPOSITIONS AND METHODS

[0001] This application claims the benefit of U.S. Provisional Application Serial Nos. 60/953,187, filed on July 31, 2007 and 61/076,584, filed on June 27, 2008, each of which is hereby incorporated by reference in its entirety.

[0002] This application cross references U.S. Provisional Application Serial Nos. 60/953,186, filed July 31, 2007; 61/076,612, filed June 27, 2008; 60/953,188, filed July 31, 2007; 61/076,608, filed June 27, 2008; 61/076, 591, filed June 27, 2008; 61/076, 578, filed June 27, 2008; and 61/076,587, filed on June 27, 2008, each of which is hereby incorporated by reference in its entirety.

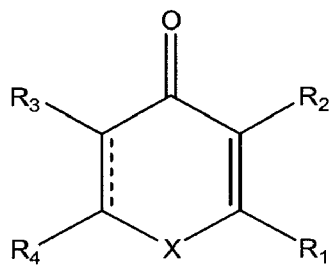
BACKGROUND OF THE INVENTION

[0003] Pyrone analogs such as flavonoids have been shown to have beneficial health effects. It has been discovered that pyrone analogs can reduce side effects caused by administration of a therapeutic agent. In another aspect, pyrone analogs can act as blood-tissue barrier (BTB) transport protein modulators, providing beneficial effects such as lowering the side effects of co-administered therapeutic agents.

[0004] Certain pyrone analogs have been described in, e.g. U. S. Patent Application Publication Nos. 2006011130 and 20060111308. This application builds upon that work.

I. SUMMARY OF THE INVENTION

[0005] In one aspect of the invention compounds are provided which include pyrone analogs of Formula I:



Formula I

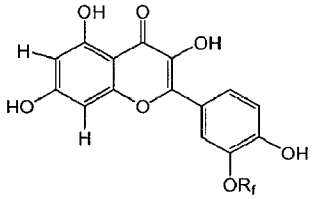
[0006] where X is O, S, or NR', and where R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

[0007] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[0008] R_3 and R_4 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

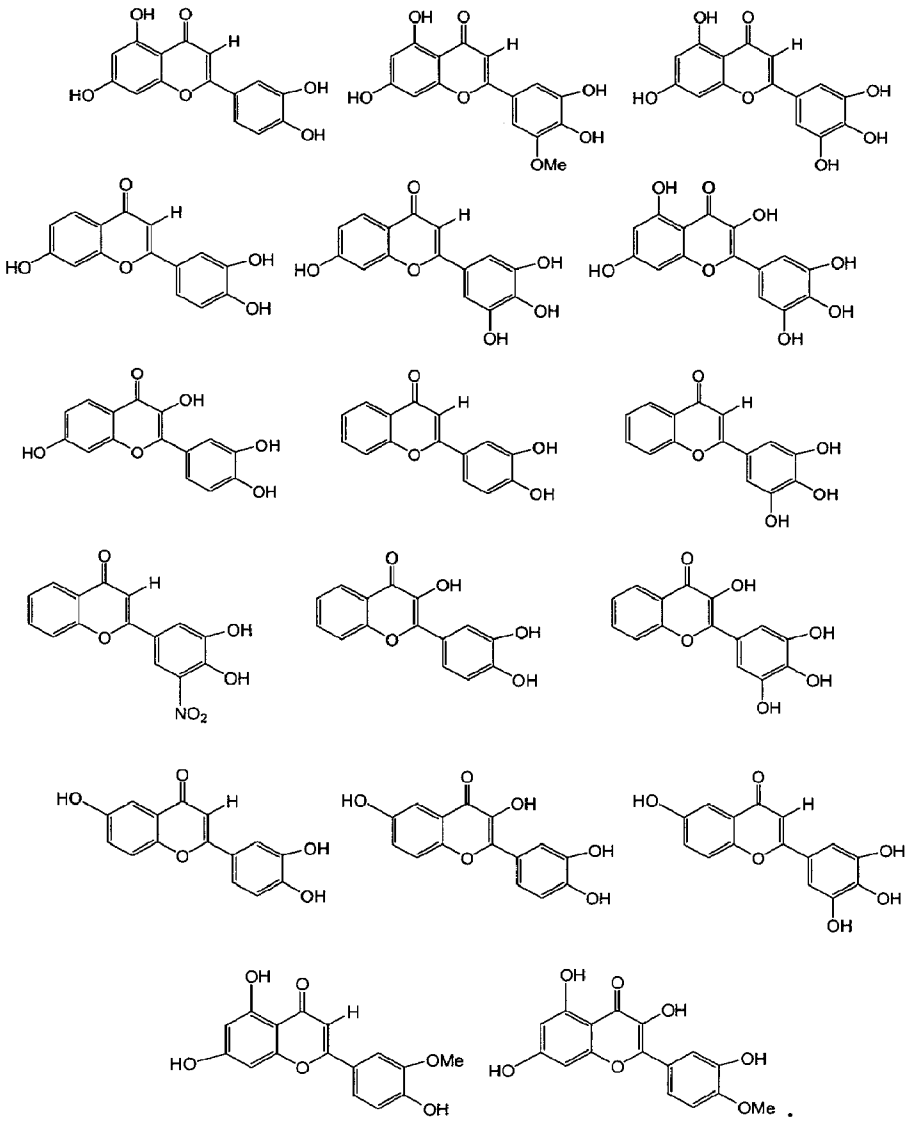
[0009] or R_3 and R_4 are taken together to form a C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, aryl, or heteroaryl;

[0010] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and



Formula A

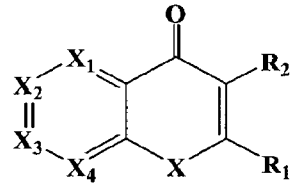
[0011] where the compound of Formula I is not the compound of Formula A when R_f is hydrogen; and where the compound of Formula I is not one of the following compounds:



[0012] In some embodiments, the compound of Formula I is not the compound of Formula A when R_f is $-PO_3K_2$.

[0013] In some embodiments of the invention, the pyrone analog of Formula I is of Formula II:

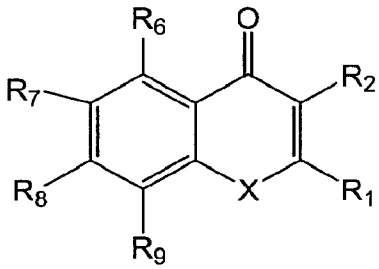
[0014]



Formula II

[0015] where X_1, X_2, X_3, and X_4 are independently CR_5, O, S, or N; and each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

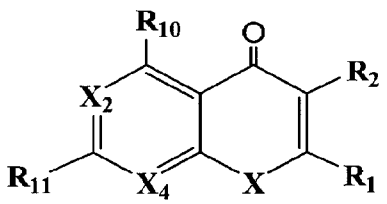
[0016] In some embodiments of the invention, the pyrone analog of Formula II is of Formula III:



Formula III

[0017] where R_6, R_7, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

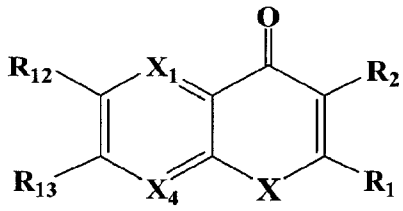
[0018] In some embodiments of the invention, the compounds of Formula II are of Formula IV:



Formula IV

[0019] where R_{10} and R_{11} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

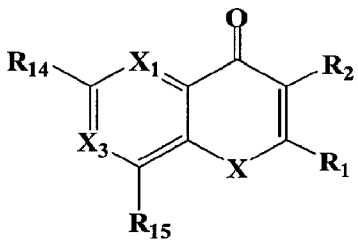
[0020] In some embodiments of the invention, the compounds of Formula II are of Formula V:



Formula V

[0021] where R_{12} and R_{13} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

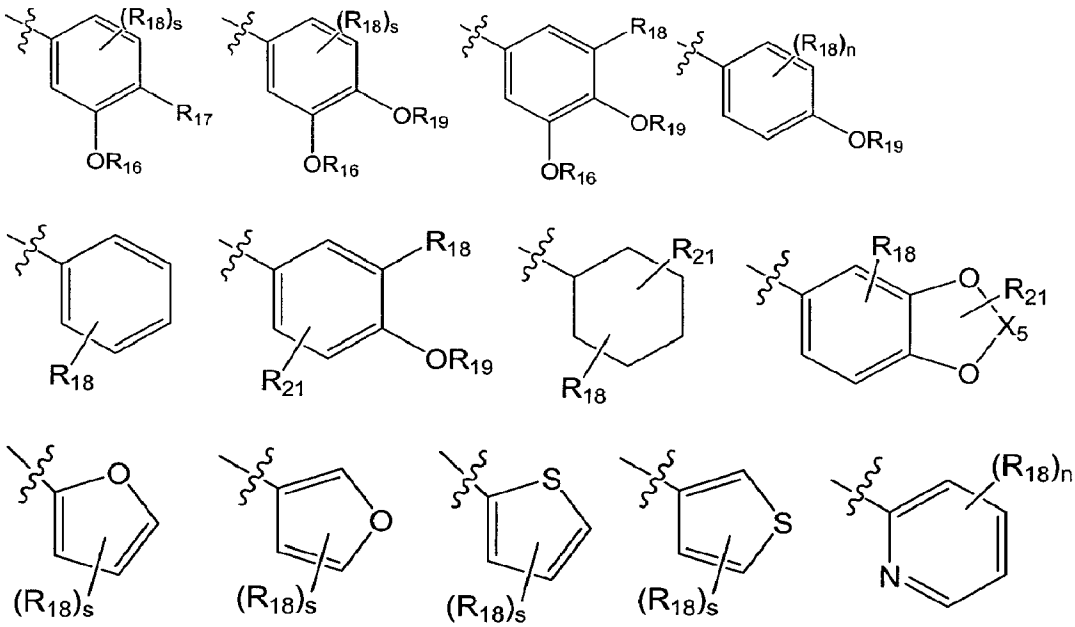
[0022] In some embodiments of the invention, the pyrone analog of Formula II is of Formula VI:

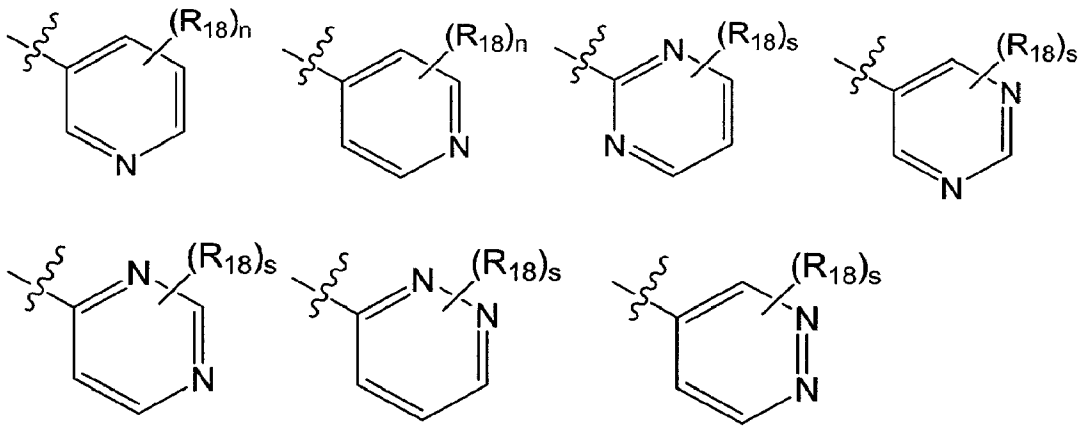


Formula VI

[0023] R_{14} and R_{15} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[0024] In various embodiments of Formulae I, II, III, IV, V, or VI, R_1 is one of the following formulae:





[0025] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[0026] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

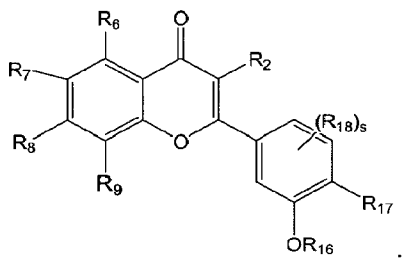
[0027] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[0028] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[0029] s is an integer of 0, 1, 2, or 3; and

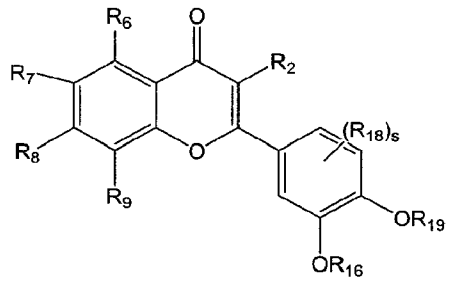
[0030] n is an integer of 0, 1, 2, 3, or 4.

[0031] In various embodiments of the invention, the pyrone analog of Formula III is of Formula VII:



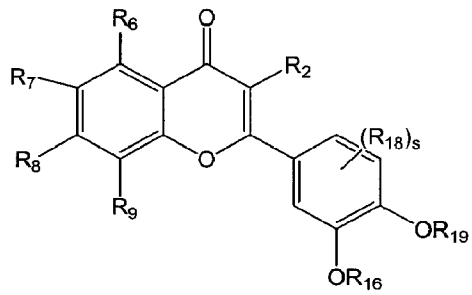
Formula VII

[0032] In other embodiments, the compound of Formula III is a compound of Formula VIII:



Formula VIII

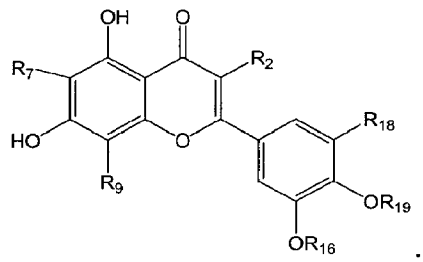
[0033] In some embodiments, the compound of Formula III is of Formula IX:



Formula IX

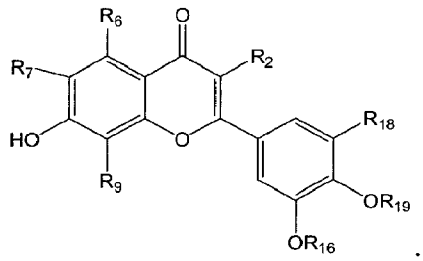
[0034] where R_6, R_7, R_8, and R_9 are independently hydrogen, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[0035] In some embodiments, the compound of Formula III is of Formula X:



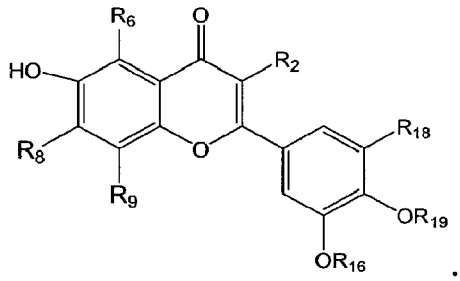
Formula X

[0036] In some embodiments, the compound of Formula III is of Formula XI:



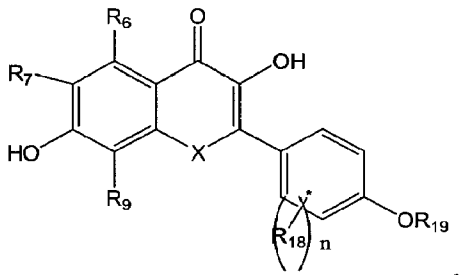
Formula XI

[0037] In some embodiments, the compound of Formula III is of Formula XII:



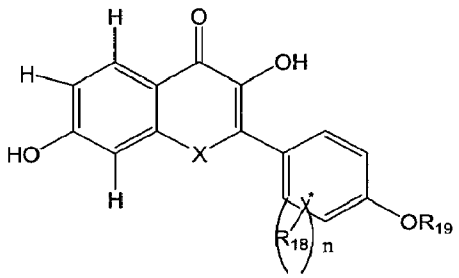
Formula XII

[0038] In some embodiments, the compound of Formula III is of Formula XIII:



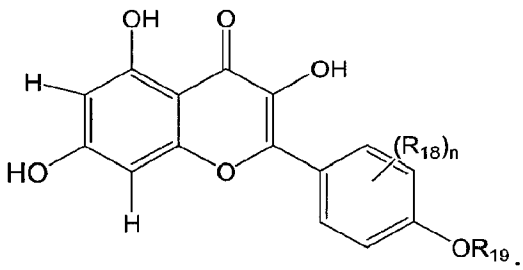
Formula XIII

[0039] In some embodiments, the compound of Formula III is of Formula XIV:



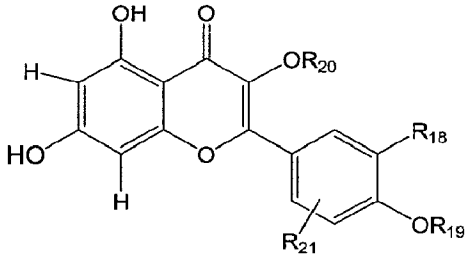
Formula XIV

[0040] In some embodiments, the compound of Formula III is of Formula XV:



Formula XV

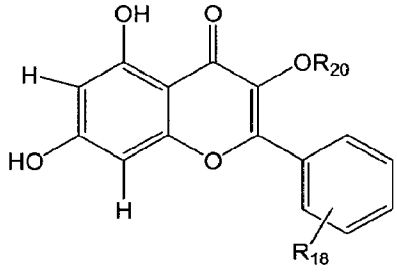
[0041] In some embodiments, the compound of Formula III is of Formula XVI:



Formula XVI

[0042] where R_{20} is independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

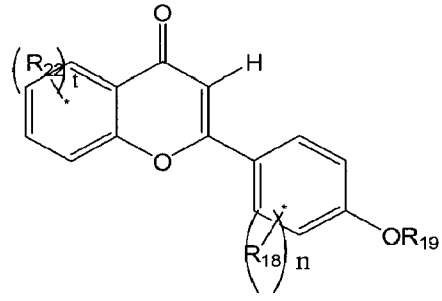
[0043] In some embodiments, the compound of Formula III is of Formula XVII:



Formula XVII

[0044] where R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

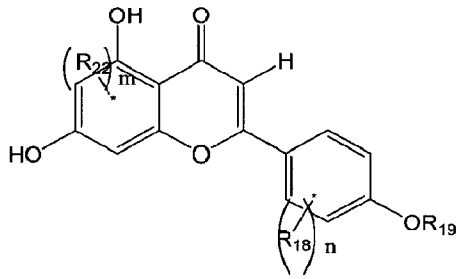
[0045] In some embodiments, the compound of Formula III is of Formula XVIII:



Formula XVIII

[0046] where each instance of R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and t is an integer of 0, 1, 2, 3, or 4.

[0047] In some embodiments, the compound of Formula III is of Formula XIX:

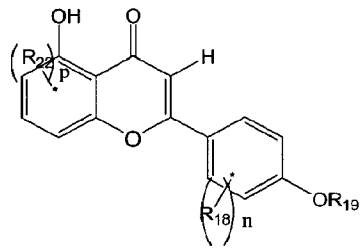


Formula XIX

[0048] where each instance of R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[0049] m is an integer of 0, 1, or 2.

[0050] In some embodiments, the compound of Formula III is of Formula XX:

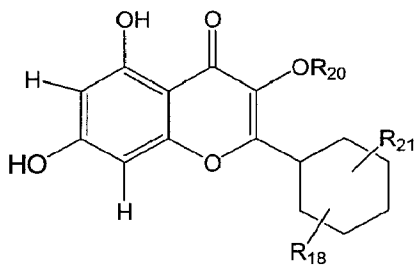


Formula XX

[0051] where each instance of R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[0052] p is an integer of 0, 1, 2 or 3.

[0053] In some embodiments, the compound of Formula III is of Formula XXI:



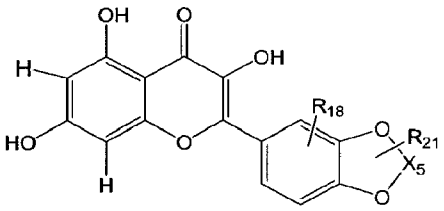
Formula XXI

[0054] where R_{21} is hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl

acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[0055] R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

[0056] In some embodiments, the compound of Formula III is of Formula XXII:



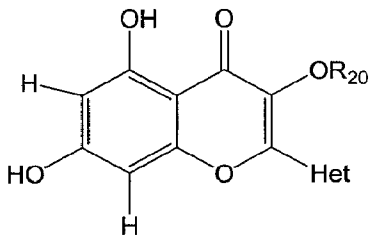
Formula XXII

[0057] wherein X_5 is a C_1 to C_4 group, optionally interrupted by O, S, NR_{23}, or $NR_{23}R_{23}$ as valency permits, forming a ring which is aromatic or nonaromatic;

[0058] wherein R_{21} is hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[0059] each instance of R_{23} is independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, acyloxy, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, heteroaryl, C_5-C_{10}heterocyclyl, , C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

[0060] In some embodiments, the compound of Formula III is of Formula XXIII:



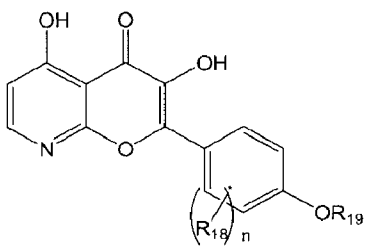
Formula XXIII

[0061] wherein R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

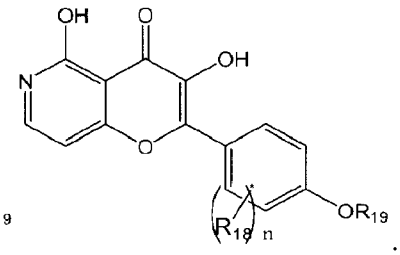
[0062] Het is a 3 to 10 membered optionally substituted monocyclic or bicyclic heteroaromatic or heteroalicyclic ring system containing 1, 2, 3, 4, or 5 heteroatoms selected from the group of O, S, and N, with the proviso that no two adjacent ring atoms are O or S, wherein the ring system is unsaturated, partially unsaturated or saturated, wherein any number of the ring atoms have substituents as valency permits which are hydrogen, hydroxyl, carboxyaldehyde, alkylcarboxaldehyde, imino, C_1-C_{10} alkyl, C_1-C_{10} alkynyl, C_1-C_{10} alkenyl, carboxyl, carbohydrate, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_5-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl,

alkoxy, amine, aryl, heteroaryl, C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[0063] In some embodiments, the compound of Formula IV is of Formula XXIV or Formula XXV:

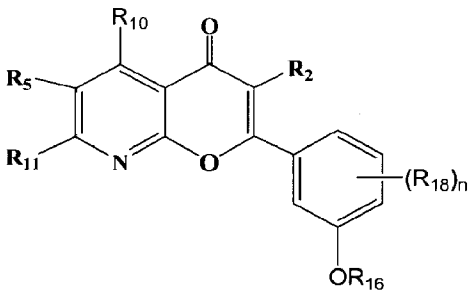


Formula XXIV

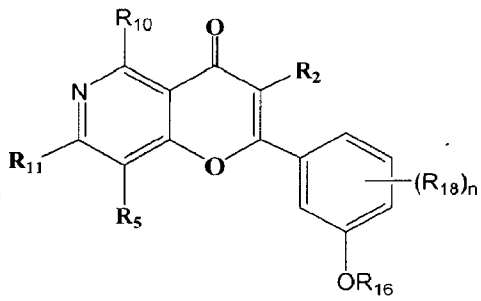


Formula XXV

[0064] In some embodiments, the compound of Formula IV is of Formula XXVI or Formula XXVII:

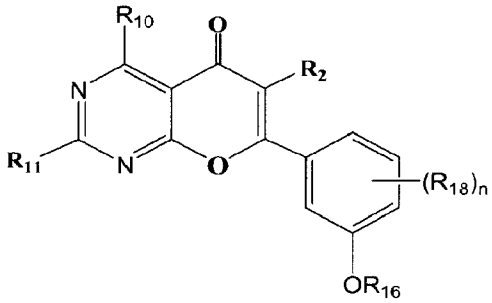


Formula XXVI



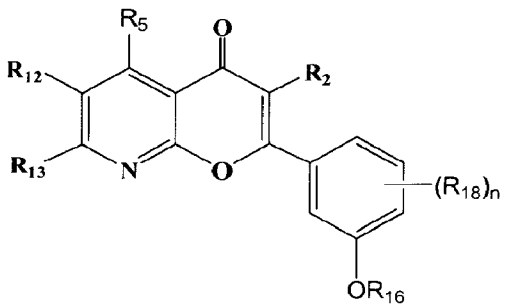
Formula XXVII

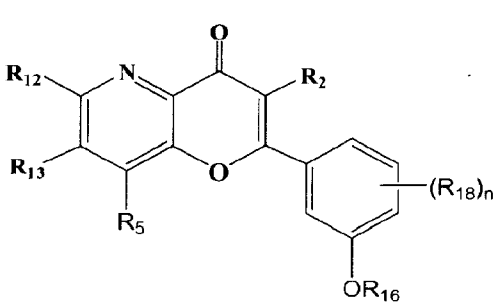
[0065] In some embodiments, the compound of Formula IV is of Formula XXVIII:



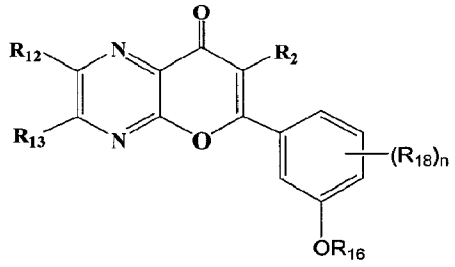
Formula XXVIII

[0066] In some embodiments, the compound of Formula V is of Formula XXIX or Formula XXX:



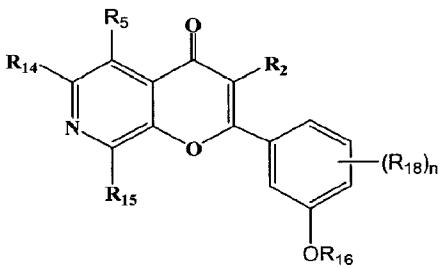


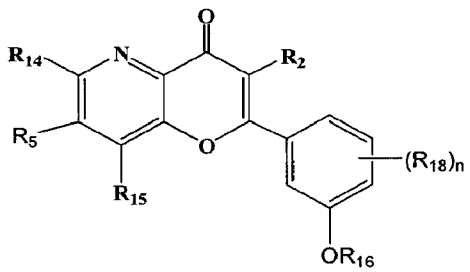
[0067] In some embodiments, the compound of Formula V is of Formula XXXI:



Formula XXXI

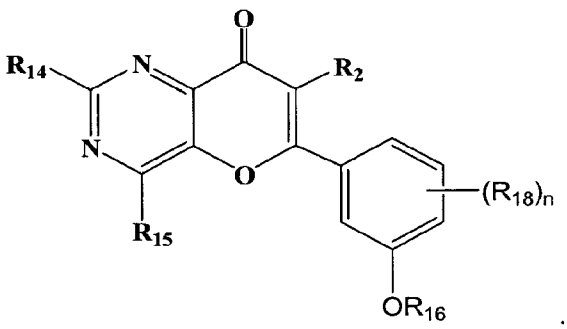
[0068] In some embodiments, the compound of Formula VI is of Formula XXXII or Formula XXXIII:





Formula XXXIII **Formula XXXIV**

[0069] In some embodiments, the compound of Formula VI is of Formula XXXIV:



Formula XXXIV

[0070] In some embodiments of the invention, R_2 is -H, -OH, $-OCH_2CH_3$, or $-OCH_3$.

[0071] In other embodiments of the invention, R_5 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

[0072] In yet other embodiments of the invention, R_6 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, or -Cl.

[0073] In other embodiments of the invention, R_7 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, or -Cl.

[0074] In some embodiments of the invention, R_8 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, -O-glucoronide, or -Cl.

[0075] In other embodiments of the invention, R_9 is -H, -OH, $-OCH_2CH_3$, or $-OCH_3$.

[0076] In some embodiments of the invention, R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

[0077] In other embodiments of the invention, R_{17} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

[0078] In some embodiments of the invention, R_{18} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, –Cl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[0079] In other embodiments of the invention, R_{19} is –H, $–CH_3$, $-CH_2CH_3$, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

[0080] In some embodiments of the invention, WY is H_2, Na_2, or K_2.

[0081] In other embodiments of the invention, Z is Ca or Mg.

[0082] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$,

[0083] In another aspect of the invention, a pharmaceutical composition is provided comprising a compound of Formula I and a pharmaceutically acceptable carrier.

DETAILED DESCRIPTION OF THE INVENTION

[0084] Reference will now be made in detail to particularly preferred embodiments of the invention. Examples of the preferred embodiments are illustrated in the following Examples section.

[0085] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as is commonly understood by one of skill in the art to which this invention belongs. All patents and publications referred to herein are incorporated by reference.

Introduction

[0086] This invention provides compositions and methods utilizing pyrone analogs and their metabolites. Pyrone analogs, for example, flavonoids can enhance the effectiveness of therapeutic agents, for example, immunosuppressants or analgesics when administered in combination with such agents (see U. S. Patent Application Serial Nos. 11/281,771, 11/281,984, and 11/553,924, and "Soluble Pyrone Analogs Methods and Compositions" Attorney Docket No. 31423-716.102, " Phosphorylated Pyrone Analogs and Methods" Attorney Docket No. 31423-720.102, "Methods and Compositions for Therapeutic Treatment" Attorney Docket No. 31423-732.101, "Methods and Compositions for Therapeutic Treatment" Attorney Docket No. 31423-733.101, and "Methods and Compositions for Therapeutic Treatment" Attorney Docket No. 31423-734.101, all of which are herein incorporated by reference in their entirety). Pyrone analogs of the invention may be used to modulate an effect caused by the therapeutic agent; e.g., to treat an animal suffering from a condition (e.g. side effect) caused by administration of a therapeutic agent. In some therapeutic interventions, administration of a therapeutic agent to an animal, which treats a first condition or disorder, causes a side effect, e.g., a second condition or disorder having one or more symptoms distinct from those of the first condition or disorder. This invention also provides novel analogs of these compounds which can have increased effectiveness, e.g., increased modulatory activity, solubility, and/or bioavailability, particularly oral bioavailability. In some embodiments, the compounds act in combination with a therapeutic agent to reduce side effects and/or enhance the effectiveness of the therapeutic agent. The pyrone analogs of the invention may comprise a monocylic or bicyclic nucleus, which may have nitrogen or oxygen substitution within the ring, thus encompassing heteroaromatic compounds in the definition of the aromatic compounds of the invention. These compounds may further comprise an aromatic or heteroaromatic moiety attached to one of the ring carbon atoms. The novel pyrone analogs of the invention may additionally comprise substituents including carbohydrate derivatization on one or more of the hydroxyl moieties. In some embodiments of the invention, the compounds of the present invention can have increased time course of drug effect, in some cases having a longer half life of drug effect, thus prolonging the effects of reducing side effects and/or enhancing the effectiveness of therapeutic agents.

In another embodiment of the invention, a carbohydrate derivatized pyrone analog of the invention is metabolized to a glucuronide derivative, which is more active, more bioavailable and/or confers a longer half life of drug effect. In a further embodiment of the invention, the glucuronide derivatized pyrone analog itself is used in the compositions and methods of the invention.

[0087] In one aspect, the invention provides compositions and methods utilizing pyrone analogs as agents which reduce or eliminate a side effect of one or more substances. In some embodiments, the invention provides compositions and methods utilizing a combination of a therapeutic agent and a pyrone analog of the invention and/or its metabolite that acts as an agent to reduce or eliminate one or more side effect of the therapeutic agent. Typically, the effect-decreasing agent is a modulator of a blood tissue barrier (BTB) or a placental barrier transport protein. The methods and compositions are useful in the treatment of an animal in need of treatment, where it is desired that one or more effects of a substance, e.g., therapeutic agent, be reduced or eliminated. In embodiments further utilizing a therapeutic agent, the methods and compositions are useful in the treatment of an animal in need of treatment, where it is desired that one or more side effects of the therapeutic agent be reduced or eliminated while one or more of the therapeutic effects (e.g., peripheral effects) of the agent are retained or enhanced.

[0088] In some embodiments of the invention, the therapeutic agent is an immunosuppressant, such as a calcineurin inhibitor, e.g., cyclosporine, tacrolimus, or a tacrolimus analog. In some embodiments of the invention, the therapeutic agent is an analgesic agent, such as an opiate or a non-opiate analgesic. In some embodiments of the invention, the therapeutic agent is a non-analgesic agent. The polyphenol and/or its metabolite acting as an agent causing a decrease in the side effects of the therapeutic agent, e.g., a modulator of a BTB transport protein may be an activator or an inhibitor of the protein. The modulatory effect may be dose-dependent, e.g., some modulators act as activators in one dosage range and inhibitors in another. In some embodiments, a modulator of a BTB transport protein is used in a dosage wherein it acts primarily as an activator.

[0089] Typically, the use of a pyrone analog of the invention and/or its metabolite, results in a decrease in one or more side effects of the therapeutic agent. The therapeutic effect(s) of the agent may be decreased, remain the same, or increase; however, in preferred embodiments, if the therapeutic effect is decreased, it is not decreased to the same degree as the side effects. It will be appreciated that a given therapeutic agent may have more than one therapeutic effect and or one or more side effects, and it is possible that the therapeutic ratio (in this case, the ratio of change in desired effect to change in undesired effect) may vary depending on which effect is measured. However, in some embodiments, at least one therapeutic effect of the therapeutic agent is decreased to a lesser degree than at least one side effect of the therapeutic agent.

[0090] In addition, in some embodiments, one or more therapeutic effects of the agent is enhanced by use in combination with a pyrone analog of the invention and/or its metabolite acting, optionally while one or more side effects of the therapeutic agent is reduced or substantially eliminated. For example, in some embodiments, the analgesic effect of an analgesic agent is enhanced while one or more CNS effects of the agent is reduced or substantially eliminated.

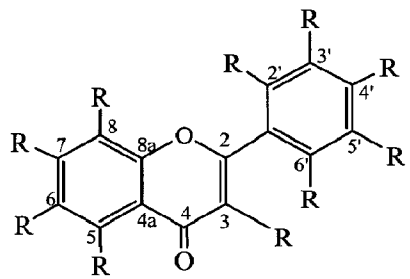
[0091] Without being bound by theory, and as an example only of a possible mechanism, it is thought that the methods and compositions of the invention operate by reducing or eliminating the concentration of the therapeutic agent from one or more compartments of the body, while retaining or even increasing the effective concentration of the agent in the other compartments.

[0092] A pyrone analog of the invention may be converted *in vivo* to metabolites that have differing activities in the modulation of one or more BTB transport modulators, and these metabolites are also encompassed by the compositions and methods of the invention.

II. PYRONE ANALOGS OF THE INVENTION

[0093] As used herein and in the appended claims, the singular forms "a," "and," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a compound" includes a plurality of such compounds, and reference to "the cell" includes reference to one or more cells (or to a plurality of cells) and equivalents thereof known to those skilled in the art, and so forth. When ranges are used herein for physical properties, such as molecular weight, or chemical properties, such as chemical formulae, all combinations and subcombinations of ranges and specific embodiments therein are intended to be included. The term "about" when referring to a number or a numerical range means that the number or numerical range referred to is an approximation within experimental variability (or within statistical experimental error), and thus the number or numerical range may vary between 1% and 15% of the stated number or numerical range. The term "comprising" (and related terms such as "comprise" or "comprises" or "having" or "including") is not intended to exclude that in other certain embodiments, for example, an embodiment of any composition of matter, composition, method, or process, or the like, described herein, may "consist of" or "consist essentially of" the described features.

[0094] Compounds useful in the invention include compounds having a general formula corresponding to Formula Q, where the numbering of atom centers is as shown, and is used throughout the specification. The numbering is retained even for analogs with variant structures, i.e., heteroatom substitution.



Formula Q

[0095] "Acyl" refers to a --(C=O)- radical which is attached to two other moieties through the carbon atom. Those groups may be chosen from alkyl, alkenyl, alkynyl, aryl, heterocylic, heteroaliphatic, heteroaryl, and the like. Unless stated otherwise specifically in the specification, an acyl group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[0096] "Acyloxy" refers to a R(C=O)O- radical wherein R is alkyl, aryl, heteroaryl or heterocyclyl. Unless stated otherwise specifically in the specification, an acyloxy group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2) $-S(O)_tN(R^a)_2$ (where t is 1 or 2) , $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[0097] "Alkylaryl" refers to an (alkyl)aryl– radical, where alkyl and aryl are as defined herein.

[0098] "Aralkyl" refers to an (aryl)alkyl— radical where aryl and alkyl are as defined herein.

[0099] "Alkoxy" refers to a (alkyl)O–radical, where alkyl is as described herein and contains 1 to 10 carbons (e.g., C_1-C_{10} alkyl). Whenever it appears herein, a numerical range such as "1 to 10" refers to each integer in the given range; e.g., "1 to 10 carbon atoms" means that the alkyl group may consist of 1 carbon atom, 2 carbon atoms, 3 carbon atoms, etc., up to and including 10 carbon atoms. In some embodiments, it is a C_1-C_4 alkoxy group. A alkoxy moiety is optionally substituted by one or more of the substituents described as suitable substituents for an alkyl radical.

[00100] "Alkyl" refers to a straight or branched hydrocarbon chain radical consisting solely of carbon and hydrogen atoms, containing no unsaturation, having from one to ten carbon atoms (*e.g.*, C_1-C_{10} alkyl). Whenever it appears herein, a numerical range such as "1 to 10" refers to each integer in the given range; e.g., "1 to 10 carbon atoms" means that the alkyl group may consist of 1 carbon atom, 2 carbon atoms, 3 carbon atoms, etc., up to and including 10 carbon atoms, although the present definition also covers the occurrence of the term "alkyl" where no numerical range is designated. Typical alkyl groups include, but are in no way limited to, methyl, ethyl, propyl, isopropyl, n-butyl, iso-butyl, sec-butyl isobutyl, tertiary butyl, pentyl, isopentyl, neopentyl, hexyl, septyl, octyl, nonyl, decyl, and the like. The alkyl is attached to the rest of the molecule by a single bond, for example, methyl (Me), ethyl (Et), *n*-propyl, 1-methylethyl (*iso*-propyl), *n*-butyl, *n*-pentyl, 1,1-dimethylethyl (*t*-butyl), 3-methylhexyl, 2-methylhexyl, and the like. Unless stated otherwise specifically in the specification, an alkyl group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00101] An "alkene" moiety refers to a group consisting of at least two carbon atoms and at least one carbon-carbon double bond, and an "alkyne" moiety refers to a group consisting of at least two carbon atoms and at least one carbon-carbon triple bond. The alkyl moiety, whether saturated or unsaturated, may be branched, straight chain, or cyclic.

[00102] "Alkenyl" refers to a straight or branched hydrocarbon chain radical group consisting solely of carbon and hydrogen atoms, containing at least one double bond, and having from two to ten carbon atoms (i.e. C_2-C_{10} alkenyl). Whenever it appears herein, a numerical range such as "2 to 10" refers to each integer in the given range; e.g., "2 to 10 carbon atoms" means that the alkenyl group may consist of 2 carbon atoms, 3 carbon atoms, etc., up to and including 10 carbon atoms. In certain embodiments, an alkenyl comprises two to eight carbon atoms. In other embodiments, an alkenyl comprises two to four carbon atoms. The alkenyl is attached to the rest of the molecule by a single bond, for example, ethenyl (*i.e.*, vinyl), prop-1-enyl (*i.e.*, allyl), but-1-enyl, pent-1-enyl, penta-1,4-dienyl, and the like. Unless stated otherwise specifically in the specification, an alkenyl group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00103] "Alkynyl" refers to a straight or branched hydrocarbon chain radical group consisting solely of carbon and hydrogen atoms, containing at least one triple bond, having from two to ten carbon atoms (i.e. C_2-C_{10} alkynyl). Whenever it appears herein, a numerical range such as "2 to 10" refers to each integer in the given range; e.g., "2 to 10 carbon atoms" means that the alkynyl group may consist of 2 carbon atoms, 3 carbon atoms, etc., up to and including 10 carbon atoms. In certain embodiments, an alkynyl comprises two to eight carbon atoms. In other embodiments, an alkynyl has two to four carbon atoms. The alkynyl is attached to the rest of the molecule by a single bond, for example, ethynyl, propynyl, butynyl, pentynyl, hexynyl, and the like. Unless stated otherwise specifically in the specification, an alkynyl group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00104] "Amine" refers to a $-N(R^a)_2$ radical group, where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl, unless stated otherwise specifically in the specification . Unless stated otherwise specifically in the specification, an amino group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00105] An "amide" refers to a chemical moiety with formula –C(O)NHR or –NHC(O)R, where R is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon). An amide may be an amino acid or a peptide molecule attached to a compound of Formula (I), thereby forming a prodrug. Any amine, hydroxy, or carboxyl side chain on the compounds described herein can be amidified. The procedures and specific groups to make such amides are known to those of skill in the art and can readily be found in reference sources such as Greene and Wuts, Protective Groups in Organic Synthesis, 3.sup.rd Ed., John Wiley & Sons, New York, N.Y., 1999, which is incorporated herein by reference in its entirety.

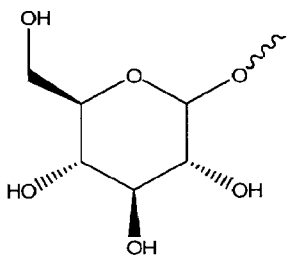
[00106] "Aromatic" or "aryl" refers to an aromatic radical with six to ten ring atoms (e.g., C_6-C_{10} aromatic or C_6-C_{10} aryl) which has at least one ring having a conjugated pi electron system and includes both carbocyclic aryl (e.g., phenyl, fluorenyl, and naphthyl) and heterocyclic aryl (or "heteroaryl" or "heteroaromatic") groups (e.g., pyridine). Whenever it appears herein, a numerical range such as "6 to 10" refers to each integer in the given range; e.g., "6 to 10 ring atoms" means that the aryl group may consist of 6 ring atoms, 7 ring atoms, etc., up to and including 10 ring atoms. The term includes monocyclic or fused-ring polycyclic (i.e., rings which share adjacent pairs of ring atoms) groups. Unless stated otherwise specifically in the specification, an aryl moiety is optionally substituted by one or more substituents which are independently: hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, –CN $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where

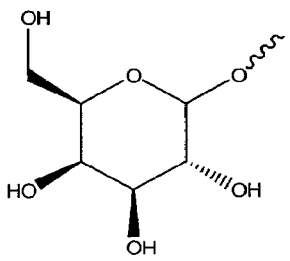
t is 1 or 2), -OPO_3WY (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

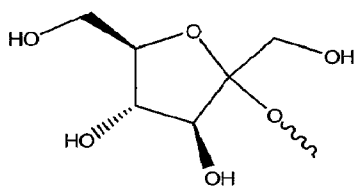
[00107] "Carboxaldehyde" refers to a –(C=O)H radical.

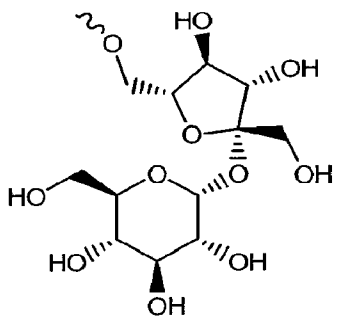
[00108] "Carboxyl" refers to a –(C=O)OH radical.

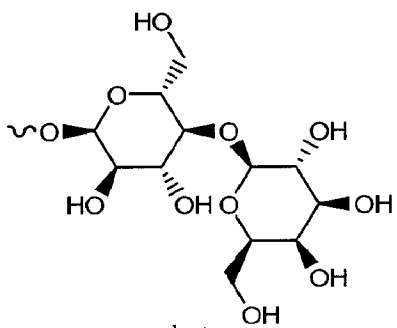
[00109] "Carbohydrate" as used herein, includes, but not limited to, monosaccharides, disaccharides, oligosaccharides, or polysaccharides. Monosaccharide for example includes, but not limited to, aldotrioses such as glyceraldehyde, ketotrioses such as dihydroxyacetone, aldotetroses such as erythrose and threose, ketotetroses such as erythrulose, aldopentoses such as arabinose, lyxose, ribose and xylose, ketopentoses such as ribulose and xylulose, aldohexoses such as allose, altrose, galactose, glucose, gulose, idose, mannose and talose, ketohexoses such as fructose, psicose, sorbose and tagatose, heptoses such as mannoheptulose, sedoheptulose, octoses such as octolose, 2-keto-3-deoxy-manno-octonate, nonoses such as sialoseallose. Disaccharides for example includes, but not limited to, glucorhamnose, trehalose, sucrose, lactose, maltose, galactosucrose, *N*-acetyllactosamine, cellobiose, gentiobiose, isomaltose, melibiose, primeverose, hesperodinose, and rutinose. Oligosaccharides for example includes, but not limited to, raffinose, nystose, panose, cellotriose, maltotriose, maltotetraose, xylobiose, galactotetraose, isopanose, cyclodextrin (α-CD) or cyclomaltohexaose, β-cyclodextrin (β-CD) or cyclomaltoheptaose and γ-cyclodextrin (γ-CD) or cyclomaltooctaose. Polysaccharide for example includes, but not limited to, xylan, mannan, galactan, glucan, arabinan, pustulan, gellan, guaran, xanthan, and hyaluronan. Some examples include, but not limited to, starch, glycogen, cellulose, inulin, chitin, amylose and amylopectin.

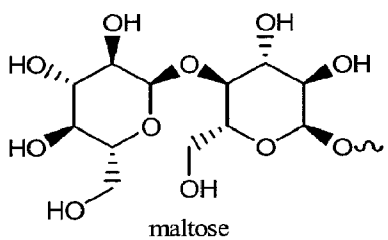

glucose


galactose


fructose


sucrose


lactose


maltose

[00110] A compound of Formula I having a carbohydrate moeity can be referred to as the pyrone aromatic glycoside or the pyrone aromatic saccharide. As used herein, "carbohydrate" further encompasses the glucuronic as well as the glycosidic derivative of compounds of Formula I. Where the pyrone analog has no carbohydrate moeity, it can be referred to as the aglycone. Further, where a phenolic hydroxy is derivatized with any of the carbohydrates described above, the carbohydrate moiety is referred to as a glycosyl residue. Unless stated otherwise specifically in the specification, a carbohydrate group is optionally substituted by one or more substituents which are

independently: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00111] "Cyano" refers to a –CN moiety.

[00112] "Cycloalkyl" refers to a monocyclic or polycyclic radical that contains only carbon and hydrogen, and may be saturated, partially unsaturated, or fully unsaturated. Cycloalkyl groups include groups having from 3 to 10 ring atoms (i.e. C_2-C_{10} cycloalkyl). Whenever it appears herein, a numerical range such as "3 to 10" refers to each integer in the given range; e.g., "3 to 10 carbon atoms" means that the cycloalkyl group may consist of 3 carbon atoms, etc., up to and including 10 carbon atoms. Illustrative examples of cycloalkyl groups include, but are not limited to the following moieties: cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloseptyl, cyclooctyl, cyclononyl, cyclodecyl, norbornyl, and the like. Unless stated otherwise specifically in the specification, a cycloalkyl group is optionally substituted by one or more substituents which are independently: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00113] "Ester" refers to a chemical radical of formula –COOR, where R is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon). Any amine, hydroxy, or carboxyl side chain on the compounds described herein can be esterified. The procedures and specific groups to make such esters are known to those of skill in the art and can readily be found in reference sources such as Greene and Wuts, Protective Groups in Organic Synthesis, 3.sup.rd Ed., John Wiley & Sons, New York, N.Y., 1999, which is incorporated herein by reference in its entirety. Unless stated otherwise specifically in the specification, an ester group is optionally substituted by one or more substituents which are independently : halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, $-OR^a$, $-SR^a$, $-OC(O)-R^a$, $-N(R^a)_2$, $-C(O)R^a$, $-C(O)OR^a$, $-C(O)N(R^a)_2$, $-N(R^a)C(O)OR^a$, $-N(R^a)C(O)R^a$, $-N(R^a)S(O)_tR^a$ (where t is 1 or 2), $-S(O)_tOR^a$ (where t is 1 or 2),$-S(O)_tN(R^a)_2$ (where t is 1 or 2), $-OPO_3WY$ (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00114] "Fluoroalkyl" refers to an alkyl radical, as defined above, that is substituted by one or more fluoro radicals, as defined above, for example, trifluoromethyl, difluoromethyl, 2,2,2-trifluoroethyl, 1-fluoromethyl-2-fluoroethyl, and the like. The alkyl part of the fluoroalkyl radical may be optionally substituted as defined above for an alkyl group.

[00115] "Halo", "halide", or, alternatively, "halogen" means fluoro, chloro, bromo or iodo. The terms "haloalkyl," "haloalkenyl," "haloalkynyl" and "haloalkoxy" include alkyl, alkenyl, alkynyl and alkoxy structures that are substituted with one or more halo groups or with combinations thereof. For example, the terms "fluoroalkyl" and "fluoroalkoxy" include haloalkyl and haloalkoxy groups, respectively, in which the halo is fluorine.

[00116] The terms "heteroalkyl" "heteroalkenyl" and "heteroalkynyl" include optionally substituted alkyl, alkenyl and alkynyl radicals and which have one or more skeletal chain atoms selected from an atom other than carbon, e.g., oxygen, nitrogen, sulfur, phosphorus or combinations thereof.

[00117] "Heteroaryl" or, alternatively, "heteroaromatic" refers to a 5- to 18-membered aryl group (e.g., C_5-C_{13} heteroaryl) that includes one or more ring heteroatoms selected from nitrogen, oxygen and sulfur, and which may be a monocyclic, bicyclic, tricyclic or tetracyclic ring system. Whenever it appears herein, a numerical range such as "5 to 18" refers to each integer in the given range; e.g., "5 to 18 ring atoms" means that the heteroaryl group may consist of 5 ring atoms, 6 ring atoms, etc., up to and including 18 ring atoms. An N-containing "heteroaromatic" or "heteroaryl" moiety refers to an aromatic group in which at least one of the skeletal atoms of the ring is a nitrogen atom. The polycyclic heteroaryl group may be fused or non-fused. The heteroatom(s) in the heteroaryl radical is optionally oxidized. One or more nitrogen atoms, if present, are optionally quaternized. The heteroaryl is attached to the rest of the molecule through any atom of the ring(s). Examples of heteroaryls include, but are not limited to, azepinyl, acridinyl, benzimidazolyl, benzindolyl, 1,3-benzodioxolyl, benzofuranyl, benzooxazolyl, benzo[d]thiazolyl, benzothiadiazolyl, benzo[*b*][1,4]dioxepinyl, benzo[b][1,4]oxazinyl, 1,4-benzodioxanyl, benzonaphthofuranyl, benzoxazolyl, benzodioxolyl, benzodioxinyl, benzoxazolyl, benzopyranyl, benzopyranonyl, benzofuranyl, benzofuranonyl, benzofurazanyl, benzothiazolyl, benzothienyl (benzothiophenyl), benzothieno[3,2-d]pyrimidinyl, benzotriazolyl, benzo[4,6]imidazo[1,2-a]pyridinyl, carbazolyl, cinnolinyl, cyclopenta[d]pyrimidinyl, 6,7-dihydro-5H-cyclopenta[4,5]thieno[2,3-d]pyrimidinyl, 5,6-dihydrobenzo[h]quinazolinyl, 5,6-dihydrobenzo[h]cinnolinyl, 6,7-dihydro-5H-benzo[6,7]cyclohepta[1,2-c]pyridazinyl, dibenzofuranyl, dibenzothiophenyl, furanyl, furazanyl, furanonyl, furo[3,2-c]pyridinyl, 5,6,7,8,9,10-hexahydrocycloocta[d]pyrimidinyl, 5,6,7,8,9,10-hexahydrocycloocta[d]pyridazinyl, 5,6,7,8,9,10-hexahydrocycloocta[d]pyridinyl, isothiazolyl, imidazolyl, indazolyl, indolyl, indazolyl, isoindolyl, indolinyl, isoindolinyl, isoquinolyl, indolizinyl, isoxazolyl, 5,8-methano-5,6,7,8-tetrahydroquinazolinyl, naphthyridinyl, 1,6-naphthyridinonyl, oxadiazolyl, 2-oxoazepinyl, oxazolyl, oxiranyl, 5,6,6a,7,8,9,10,10a-octahydrobenzo[h]quinazolinyl, 1-phenyl-1*H*-pyrrolyl, phenazinyl, phenothiazinyl, phenoxazinyl, phthalazinyl, pteridinyl, purinyl, pyranyl, pyrrolyl, pyrazolyl, pyrazolo[3,4-d]pyrimidinyl, pyridinyl, pyrido[3,2-d]pyrimidinyl, pyrido[3,4-d]pyrimidinyl, pyrazinyl, pyrimidinyl, pyridazinyl, pyrrolyl, quinazolinyl, quinoxalinyl, quinolinyl, isoquinolinyl, tetrahydroquinolinyl, 5,6,7,8-tetrahydroquinazolinyl, 5,6,7,8-tetrahydrobenzo[4,5]thieno[2,3-d]pyrimidinyl, 6,7,8,9-tetrahydro-5H-cyclohepta[4,5]thieno[2,3-d]pyrimidinyl, 5,6,7,8-tetrahydropyrido[4,5-c]pyridazinyl, thiazolyl, thiadiazolyl, thiapyranyl, triazolyl, tetrazolyl, triazinyl, thieno[2,3-d]pyrimidinyl, thieno[3,2-d]pyrimidinyl, thieno[2,3-c]pridinyl, and thiophenyl (*i.e.* thienyl). Unless stated otherwise specifically in the specification, a heteraryl moiety is optionally substituted by one or more substituents which are independently : hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, –CN, -OR^a, -SR^a, -OC(O)-R^a, -$N(R^a)_2$, -C(O)R^a, -C(O)OR^a, -C(O)$N(R^a)_2$, -$N(R^a)C(O)OR^a$, -$N(R^a)C(O)R^a$, -$N(R^a)S(O)_tR^a$ (where t is 1 or 2), -$S(O)_tOR^a$ (where t is 1 or 2),-$S(O)_tN(R^a)_2$ (where t is 1 or 2), -OPO_3WY (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00118] "Heterocyclyl" refers to a stable 3- to 18-membered non-aromatic ring (e.g., C_3-C_{18} heterocyclyl) radical that comprises two to twelve carbon atoms and from one to six heteroatoms selected from nitrogen, oxygen and sulfur. Whenever it appears herein, a numerical range such as "3 to 18" refers to each integer in the given range; e.g., "3 to 18 ring atoms" means that the heteroaryl group may consist of 3 ring atoms, 4 ring atoms, etc., up to and including 18 ring atoms. In some embodiments, it is a C_5-C_{10} heterocyclyl. In some embodiments, it is a C_4-C_{10} heterocyclyl. In some embodiments, it is a C_3-C_{10} heterocyclyl. Unless stated otherwise specifically in the specification, the heterocyclyl radical is a monocyclic, bicyclic, tricyclic or tetracyclic ring system, which may include fused or bridged ring systems. The heteroatoms in the heterocyclyl radical may be optionally oxidized. One or more nitrogen atoms, if present, are optionally quaternized. The heterocyclyl radical is partially or fully saturated. The heterocyclyl may be attached to the rest of the molecule through any atom of the ring(s). Examples of such heterocyclyl radicals include, but are not limited to, dioxolanyl, thienyl[1,3]dithianyl, decahydroisoquinolyl, imidazolinyl, imidazolidinyl, isothiazolidinyl, isoxazolidinyl, morpholinyl, octahydroindolyl, octahydroisoindolyl, 2-oxopiperazinyl, 2-oxopiperidinyl, 2-oxopyrrolidinyl, oxazolidinyl, piperidinyl, piperazinyl, 4-piperidonyl, pyrrolidinyl, pyrazolidinyl, quinuclidinyl, thiazolidinyl, tetrahydrofuryl, trithianyl, tetrahydropyranyl, thiomorpholinyl, thiamorpholinyl, 1-oxo-thiomorpholinyl, and 1,1-dioxo-thiomorpholinyl. Unless stated otherwise specifically in the specification, a heterocylyl moiety is optionally substituted by one or more substituents which are independently: hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, –CN, -OR^a, -SR^a, -$OC(O)$-R^a, -$N(R^a)_2$, -$C(O)R^a$, -$C(O)OR^a$, -$C(O)N(R^a)_2$, -$N(R^a)C(O)OR^a$, -$N(R^a)C(O)R^a$, -$N(R^a)S(O)_tR^a$ (where t is 1 or 2), -$S(O)_tOR^a$ (where t is 1 or 2),-$S(O)_tN(R^a)_2$ (where t is 1 or 2), -OPO_3WY (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00119] "Heteroalicyclic" refers to a cycloalkyl radical that includes at least one heteroatom selected from nitrogen, oxygen and sulfur. The radicals may be fused with an aryl or heteroaryl. The term heteroalicyclic also includes all ring forms of the carbohydrates, including but not limited to the monosaccharides, the disaccharides and the oligosaccharides. Unless stated otherwise specifically in the specification, a heteroalicyclic group is optionally substituted by one or more substituents which independently are: halo, cyano, nitro, oxo, thioxo, trimethylsilanyl, -OR^a, -SR^a, -$OC(O)$-R^a, -$N(R^a)_2$, -$C(O)R^a$, -$C(O)OR^a$, -$C(O)N(R^a)_2$, -$N(R^a)C(O)OR^a$, -$N(R^a)C(O)R^a$, -$N(R^a)S(O)_tR^a$ (where t is 1 or 2), -$S(O)_tOR^a$ (where t is 1 or 2),-$S(O)_tN(R^a)_2$ (where t is 1 or 2), -OPO_3WY (where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium) or- OPO_3Z (where Z is calcium, magnesium or iron) where each R^a is independently hydrogen, alkyl, fluoroalkyl, carbocyclyl, carbocyclylalkyl, aryl, aralkyl, heterocyclyl, heterocyclylalkyl, heteroaryl or heteroarylalkyl.

[00120] "Imino" refers to the =N-H radical.

[00121] "Isocyanato" refers to a –NCO radical.

[00122] "Isothiocyanato" refers to a –NCS radical.

[00123] "Mercaptyl" refers to a (alkyl)S– or (H)S– radical.

[00124] "Moiety" refers to a specific segment or functional group of a molecule. Chemical moieties are often recognized chemical entities embedded in or appended to a molecule.

[00125] "Nitro" refers to the $–NO_2$ radical.

[00126] "Oxa" refers to the -O- radical.

[00127] "Oxo" refers to the =O radical.

[00128] "Sulfinyl" refers to a –S(=O)—R radical, where R is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon)

[00129] "Sulfonyl" refers to a $-S(=O)_2-R$ radical, where R is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon).

[00130] "Sulfonamidyl" refers to a $-S(=O)_2-NRR$ radical, where each R is selected independently from the group consisting of hydrogen, alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon).

[00131] "Sulfoxyl" refers to a $-S(=O)_2OH$ radical.

[00132] "Sulfonate" refers to a $-S(=O)_2-OR$ radical, where R is selected from the group consisting of alkyl, cycloalkyl, aryl, heteroaryl (bonded through a ring carbon) and heteroalicyclic (bonded through a ring carbon).

[00133] "Thiocyanato" refers to a –CNS radical.

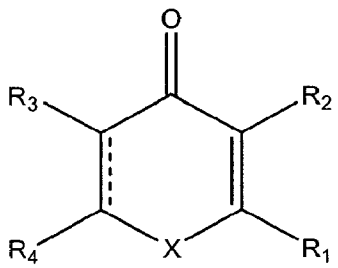
[00134] "Thioxo" refers to the =S radical.

[00135] "Substituted" means that the referenced group may be substituted with one or more additional group(s) individually and independently selected from acyl, alkyl, alkylaryl, cycloalkyl, aralkyl, aryl, carbohydrate, heteroaryl, heterocyclic, hydroxy, alkoxy, aryloxy, mercapto, alkylthio, arylthio, cyano, halo, carbonyl, ester, thiocarbonyl, isocyanato, thiocyanato, isothiocyanato, nitro, perhaloalkyl, perfluoroalkyl, phosphate, silyl, sulfinyl, sulfonyl, sulfonamidyl, sulfoxyl, sulfonate, and amino, including mono- and di-substituted amino groups, and the protected derivatives thereof. The substituents themselves may be substituted, for example, a cycloakyl substituent may have a halide substituted at one or more ring carbons, and the like. The protecting groups that may form the protective derivatives of the above substituents are known to those of skill in the art and may be found in references such as Greene and Wuts, above.

[00136] The compounds presented herein may possess one or more chiral centers and each center may exist in the R or S configuration. The compounds presented herein include all diastereomeric, enantiomeric, and epimeric forms as well as the appropriate mixtures thereof. Stereoisomers may be obtained, if desired, by methods known in the art as, for example, the separation of stereoisomers by chiral chromatographic columns.

[00137] The methods and formulations described herein include the use of N-oxides, crystalline forms (also known as polymorphs), or pharmaceutically acceptable salts of compounds having the structure of Formula (I), as well as active metabolites of these compounds having the same type of activity. In addition, the compounds described herein can exist in unsolvated as well as solvated forms with pharmaceutically acceptable solvents such as water, ethanol, and the like. The solvated forms of the compounds presented herein are also considered to be disclosed herein.

[00138] Pyrone analogs of Formula I and their pharmaceutically/veterinarily acceptable salt or esters are provided in this invention,



Formula I

[00139] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

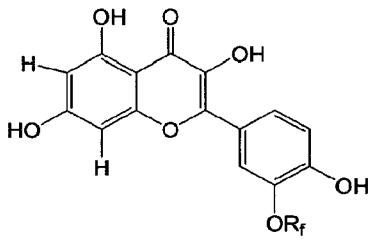
[00140] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00141] R_3 and R_4 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, Carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00142] or R_3 and R_4 are taken together to form a C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, aryl, or heteroaryl;

[00143] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

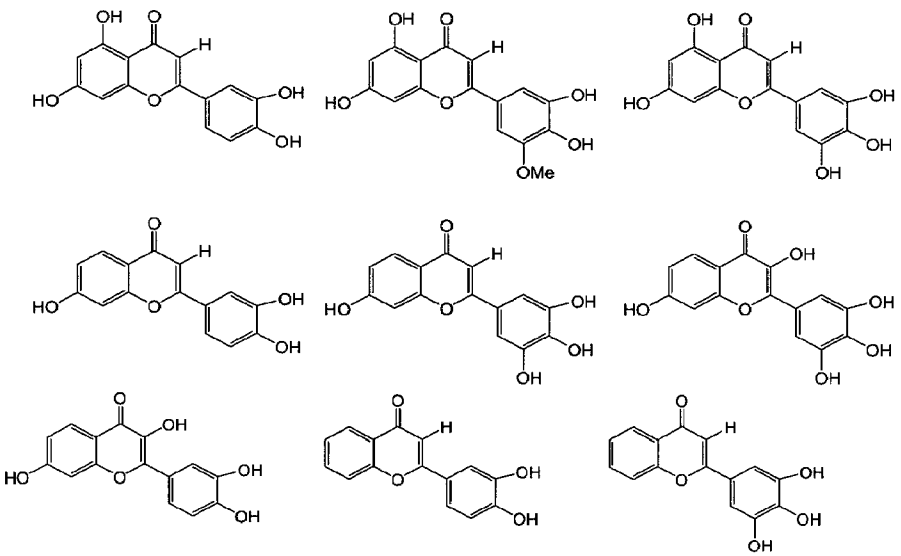
[00144] wherein the compound of Formula I is not the compound of Formula A:

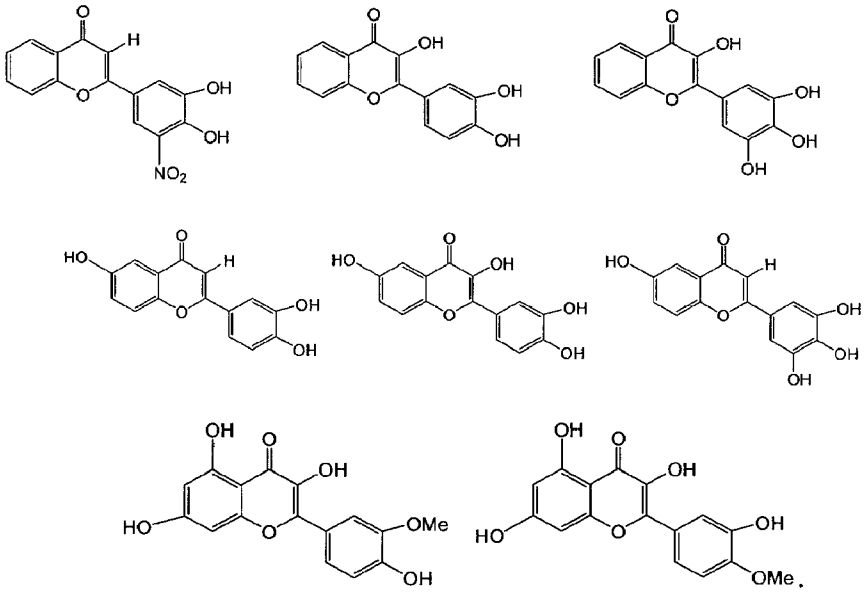


Formula A

[00145] wherein R_f is hydrogen; and

[00146] wherein the compound of Formula I is not one of the following compounds:





[00147] In some embodiments, the compound of Formula I is not the compound of Formula A wherein R_f is PO_3K_2.

[00148] In some embodiments, X is O.

[00149] In other embodiments, X is S.

[00150] In yet other embodiments, X is NR'.

[00151] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

[00152] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some

embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00153] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00154] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00155] In some embodiments, R_3 is hydrogen. In some embodiments, R_3 is hydroxyl. In some embodiments, R_3 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_3 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_3 is substituted C_1-C_{10} alkyl. In some embodiments, R_3 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_3 is substituted C_1-C_{10} alkyl. In some embodiments, R_3 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_3 is substituted C_2-C_{10} alkynyl. In some embodiments, R_3 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_3 is substituted C_2-C_{10} alkenyl. In some embodiments, R_3 is carboxyl. In some embodiments, R_3 is unsubstituted carbohydrate. In some embodiments, R_3 is substituted carbohydrate. In some embodiments, R_3 is unsubstituted ester. In some embodiments, R_3 is substituted ester. In some embodiments, R_3 is unsubstituted acyloxy. In some embodiments, R_3 is substituted acyloxy. In some embodiments, R_3 is nitro. In some embodiments, R_3 is halogen.

In some embodiments, R_3 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_3 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_3 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_3 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_3 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_3 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_3 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_3 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_3 is unsubstituted alkoxy. In some embodiments, R_3 is substituted alkoxy. In some embodiments, R_3 is unsubstituted amine. In some embodiments, R_3 is substituted amine. In some embodiments, R_3 is unsubstituted aryl. In some embodiments, R_3 is substituted aryl. In some embodiments, R_3 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_3 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_3 is unsubstituted heteroaryl. In some embodiments, R_3 is substituted heteroaryl. In some embodiments, R_3 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_3 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_3 is $-OPO_3WY$. In some embodiments, R_3 is $-OCH_2PO_4WY$. In some embodiments, R_3 is $-OCH_2PO_4Z$. In some embodiments, R_3 is $-OPO_3Z$.

[00156] In some embodiments, R_4 is hydrogen. In some embodiments, R_4 is hydroxyl. In some embodiments, R_4 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_4 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_4 is substituted C_1-C_{10} alkyl. In some embodiments, R_4 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_4 is substituted C_1-C_{10} alkyl. In some embodiments, R_4 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_4 is substituted C_2-C_{10} alkynyl. In some embodiments, R_4 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_4 is substituted C_2-C_{10} alkenyl. In some embodiments, R_4 is carboxyl. In some embodiments, R_4 is unsubstituted carbohydrate. In some embodiments, R_4 is substituted carbohydrate. In some embodiments, R_4 is unsubstituted ester. In some embodiments, R_4 is substituted ester. In some embodiments, R_4 is unsubstituted acyloxy. In some embodiments, R_4 is substituted acyloxy. In some embodiments, R_4 is nitro. In some embodiments, R_4 is halogen. In some embodiments, R_4 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_4 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_4 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_4 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_4 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_4 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_4 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_4 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_4 is unsubstituted alkoxy. In some embodiments, R_4 is substituted alkoxy. In some embodiments, R_4 is unsubstituted amine. In some embodiments, R_4 is substituted amine. In some embodiments, R_4 is unsubstituted aryl. In some embodiments, R_4 is substituted aryl. In some embodiments, R_4 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_4 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_4 is unsubstituted heteroaryl. In some embodiments, R_4 is substituted heteroaryl. In some embodiments, R_4 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_4 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_4 is $-OPO_3WY$. In some embodiments, R_4 is $-OCH_2PO_4WY$. In some embodiments, R_4 is $-OCH_2PO_4Z$. In some embodiments, R_4 is $-OPO_3Z$.

[00157] In some embodiments, R_3 and R_4 are taken together to form an unsubstituted C_5-C_{10}heterocyclyl. In other embodiments, R_3 and R_4 are taken together to form a substituted C_5-C_{10}heterocyclyl. In some embodiments, R_3 and R_4 are taken together to form an unsubstituted C_5-C_{10}cycloalkyl. In some embodiments, R_3 and R_4 are taken together to form a substituted C_5-C_{10}cycloalkyl. In some embodiments, R_3 and R_4 are taken together to form an unsubstituted aryl. In some embodiments, R_3 and R_4 are taken together to form a substituted aryl. In some embodiments, R_3 and R_4 are taken together to form an unsubstituted heteroaryl. In some embodiments, R_3 and R_4 are taken together to form a substituted heteroaryl.

[00158] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments,

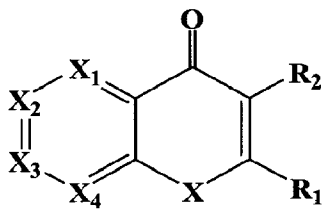
W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00159] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00160] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00161] The 2,3 bond may be saturated or unsaturated in the compounds of Formula I.

[00162] In some embodiments of the invention, the pyrone analog is of Formula II and its pharmaceutically/veterinarily acceptable salts thereof:



Formula II

[00163] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

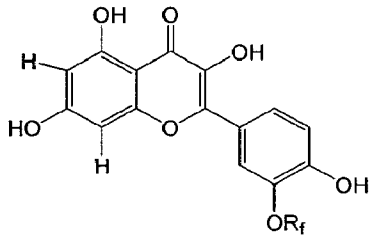
[00164] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00165] X_1, X_2, X_3, and X_4 are independently CR_5, O, S, or N;

[00166] each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, Carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00167] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

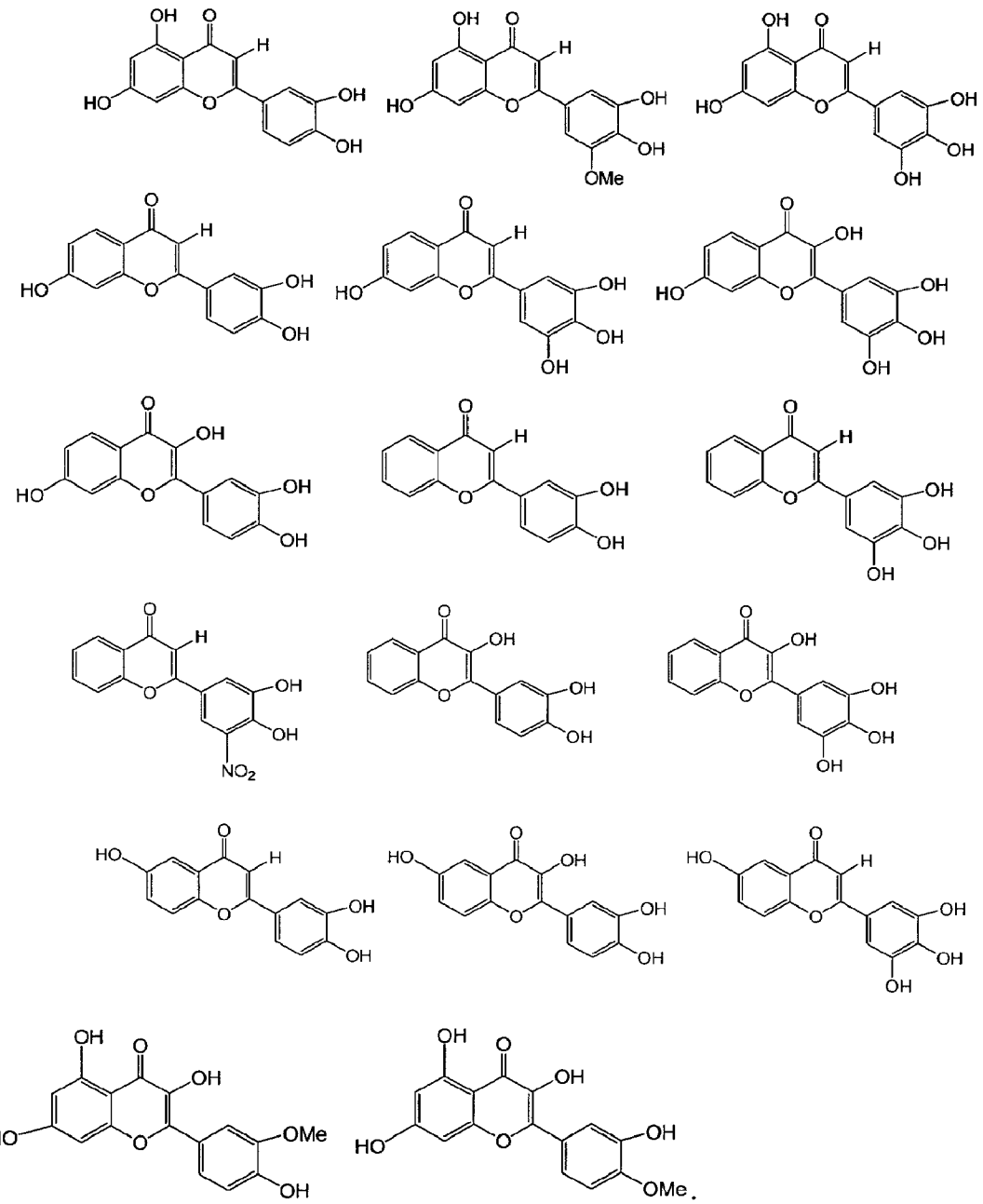
[00168] wherein the compound of Formula II is not the compound of Formula A:



Formula A

[00169] wherein R_f is hydrogen; and

[00170] wherein the compound of Formula II is not one of the following compounds:



[00171] In some embodiments, the compound of Formula II is not the compound of Formula A wherein R_f is PO_3K_2.

[00172] In some embodiments, X is O.

[00173] In other embodiments, X is S.

[00174] In yet other embodiments, X is NR'.

[00175] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

[00176] In some embodiments, X_1 is CR_5.

[00177] In other embodiments, X_1 is O.

[00178] In yet other embodiments, X_1 is S.

[00179] In further embodiments, X_1 is N.

[00180] In some embodiments, X_2 is CR_5.

[00181] In other embodiments, X_2 is O.

[00182] In yet other embodiments, X_2 is S.

[00183] In further embodiments, X_2 is N.

[00184] In some embodiments, X_3 is CR_5.

[00185] In other embodiments, X_3 is O.

[00186] In yet other embodiments, X_3 is S.

[00187] In further embodiments, X_3 is N.

[00188] In other embodiments, X_4 is CR_5.

[00189] In some embodiments, X_4 is O.

[00190] In yet other embodiments, X_4 is S.

[00191] In some embodiments, X_4 is N.

[00192] In some embodiments, X_1, X_2, X_3, and X_4 are CR_5.

[00193] In some embodiments, X_1 is N, and X_2, X_3, and X_4 are CR_5.

[00194] In some embodiments, X_2 is N, and X_1, X_3, and X_4 are CR_5;

[00195] In some embodiments, X_3 is N, and X_1, X_2, and X_4 are CR_5;

[00196] In some embodiments, X_4 is N, and X_1, X_2, and X_3 are CR_5;

[00197] In some embodiments, X_1 and X_3 are CR_5 and X_2 and X_4 are N.

[00198] In some embodiments, X_2 and X_4 are CR_5 and X_1 and X_3 are N.

[00199] In some embodiments, X_2 and X_3 are CR_5 and X_1 and X_4 are N.

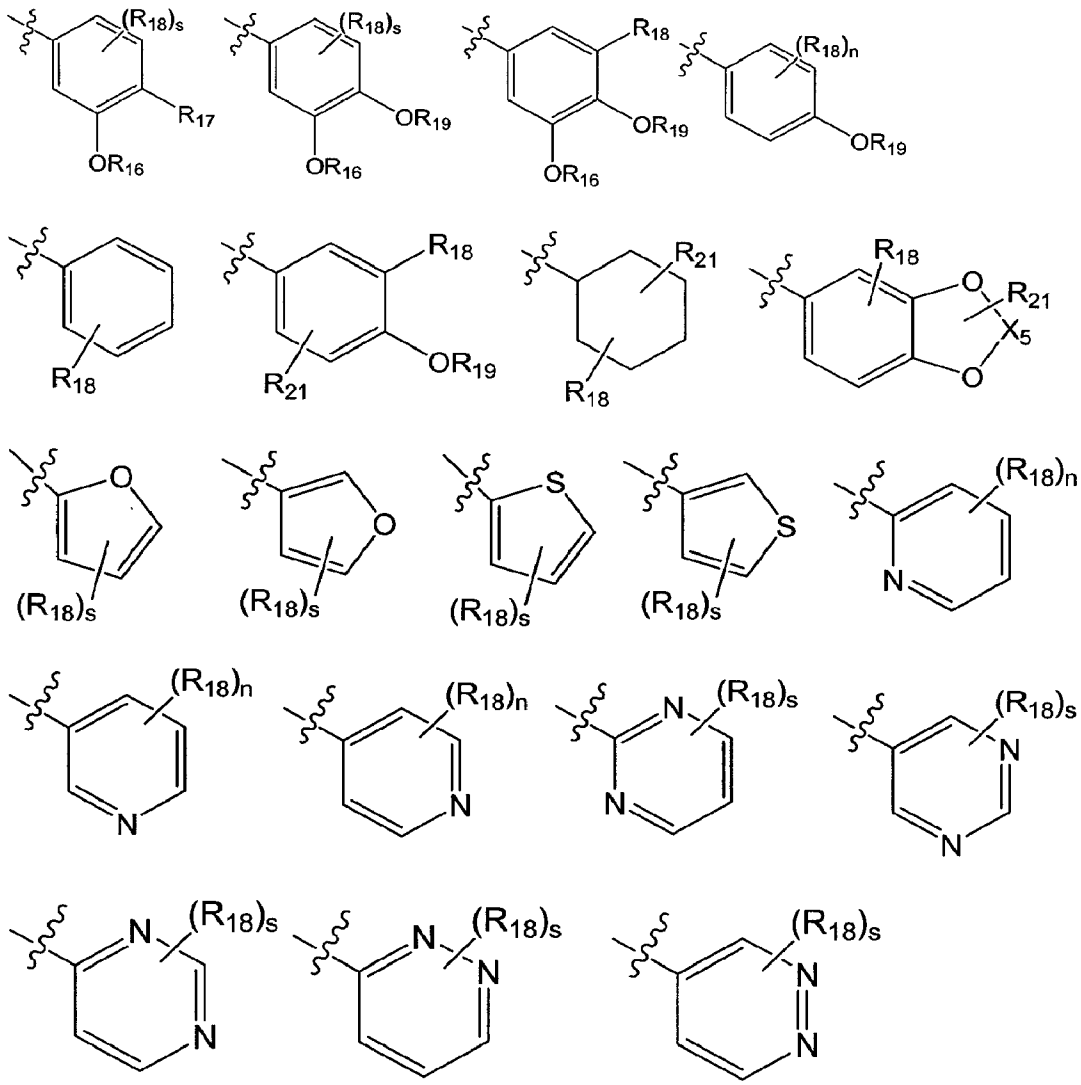
[00200] In some embodiments, at least one of X_1, X_2, X_3 or X_4 is N.

[00201] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00202] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, $R_2$is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00203] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00204] In various embodiments, R_1 is one of the following formulae:



[00205] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00206] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00207] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00208] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00209] s is an integer of 0, 1, 2, or 3; and

[00210] n is an integer of 0, 1, 2, 3, or 4.

[00211] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00212] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate l. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00213] In some embodiments, R_{17} is hydrogen. In some embodiments, R_{17} is hydroxy. In some embodiments, R_{17} is carboxaldehyde. In some embodiments, R_{17} is unsubstituted amine. In some embodiments, R_{17} is substituted amine. In some embodiments, R_{17} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is carboxyl. In some embodiments, R_{17} is unsubstituted carbohydrate. In some embodiments, R_{17} is substituted carbohydrate. In some embodiments, R_{17} is unsubstituted ester. In some embodiments, R_{17} is substituted ester. In some embodiments, R_{17} is unsubstituted acyloxy. In some embodiments, R_{17} is substituted acyloxy. In some embodiments, R_{17} is nitro. In some embodiments, R_{17} is halogen. In some embodiments, R_{17} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} alkylaryl acyl. n some embodiments, R_{17} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is unsubstituted alkoxy. In some embodiments, R_{17} is substituted alkoxy. In some embodiments, R_{17} is unsubstituted aryl. In some embodiments, R_{17} is substituted aryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is unsubstituted heteroaryl. In some embodiments, R_{17} is substituted heteroaryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is substituted C_3-C_{10}cycloalkyl. In some embodiments,

R_{17} is $-OPO_3WY$. In some embodiments, R_{17} is $-OCH_2PO_4WY$. In some embodiments, R_{17} is $-OCH_2PO_4Z$. In some embodiments, R_{17} is $-OPO_3Z$.

[00214] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00215] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00216] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some

embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00217] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

[00218] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00219] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

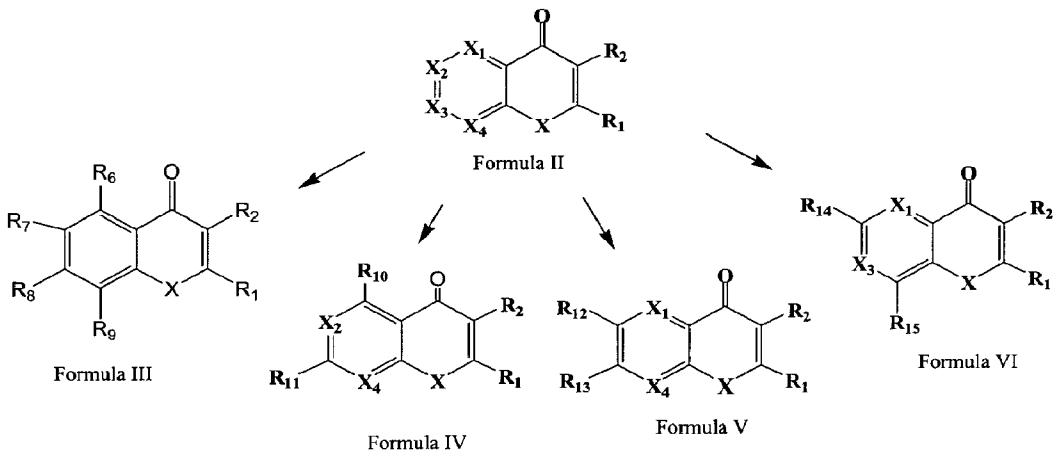
[00220] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00221] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00222] In some embodiments, R_5 is hydrogen. In some embodiments, R_5 is hydroxyl. In some embodiments, R_5 is carboxaldehyde. In some embodiments, R_5 is unsubstituted amine. In some embodiments, R_5 is substituted amine. In some embodiments, R_5 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_5 is substituted C_1-C_{10} alkyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_5 is substituted C_2-C_{10} alkynyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, $R_5$is substituted C_2-C_{10} alkenyl. In some embodiments, R_5 is carboxyl. In some embodiments, R_5 is unsubstituted carbohydrate. In some embodiments, R_5 is substituted carbohydrate. In some embodiments, R_5 is unsubstituted ester. In some embodiments, R_5 is substituted ester. In some embodiments, R_5 is unsubstituted acyloxy. In some embodiments, R_5 is substituted

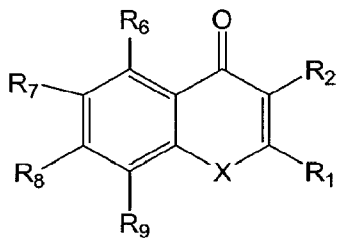
acyloxy. In some embodiments, R_5 is nitro. In some embodiments, R_5 is halogen. In some embodiments, R_5 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is unsubstituted alkoxy. In some embodiments, R_5 is substituted alkoxy. In some embodiments, R_5 is unsubstituted aryl. In some embodiments, R_5 is substituted aryl. In some embodiments, R_5 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is unsubstituted heteroaryl, In some embodiments, R_5 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is $-OPO_3WY$. In some embodiments, R_5 is $-OCH_2PO_4WY$. In some embodiments, R_5 is $-OCH_2PO_4Z$. In some embodiments, R_5 is $-OPO_3Z$.

[00223] In various embodiments of the invention, the pyrone analog is of Formulae III, IV, V, or VI as illustrated in Scheme I.



Scheme I. Exemplary subclasses of Formula II

[00224] In some embodiments of the invention where X_1, X_2, X_3, and X_4 of Formula II are CR_5, the compound is of Formula III or a pharmaceutically/veterinarily acceptable salt thereof:



Formula III

[00225] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

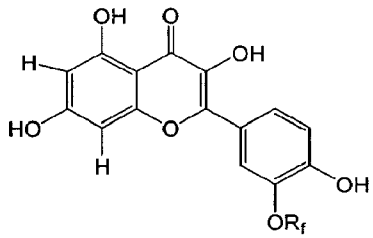
[00226] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10}

alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

[00227] R_6, R_7, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z; and

[00228] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation;

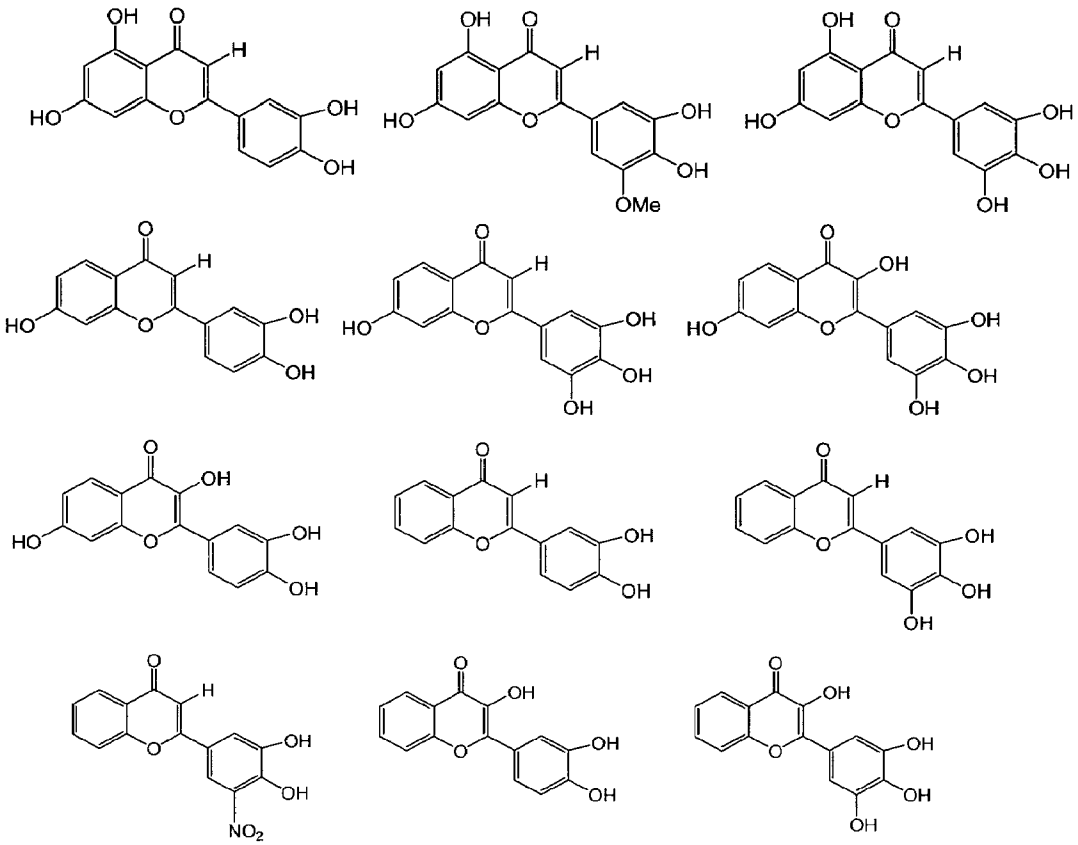
[00229] wherein the compound of Formula III is not the compound of Formula A:

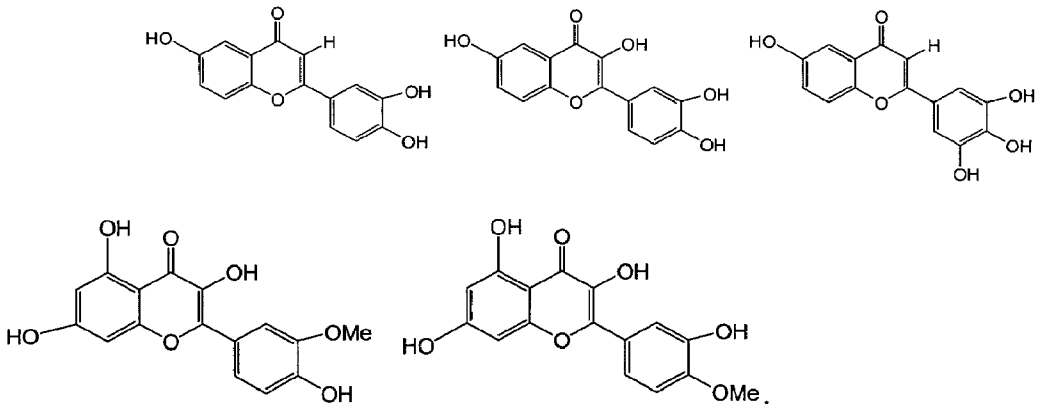


Formula A

[00230] wherein R_f is hydrogen; and

[00231] wherein the compound of Formula III is not one of the following compounds:





[00232] In some embodiments, the compound of Formula III is not the compound of Formula A wherein R_f is PO_3K_2.

[00233] In some embodiments, X is O.

[00234] In other embodiments, X is S.

[00235] In yet other embodiments, X is NR'.

[00236] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

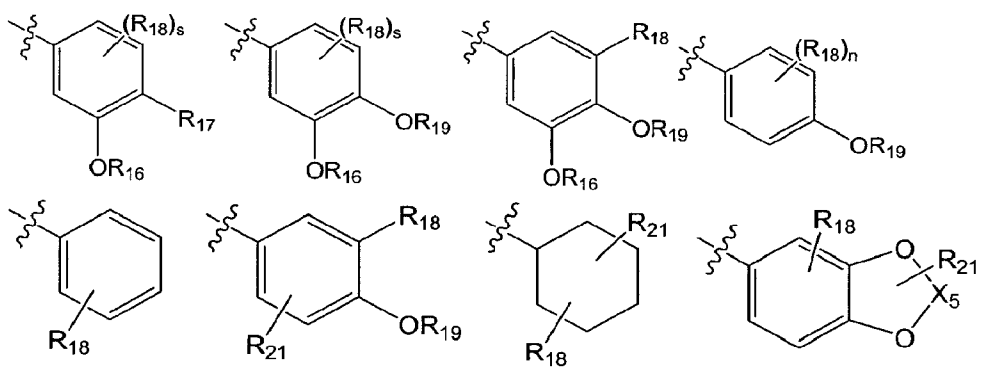
[00237] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In

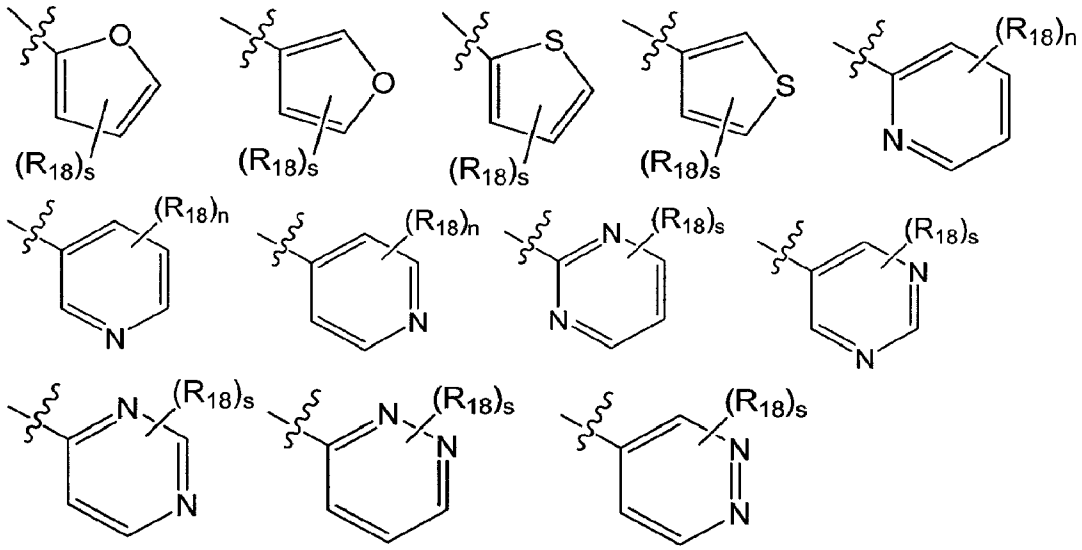
some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00238] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, $R_2$is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00239] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00240] In various embodiments, R_1 is one of the following formulae:





[00241] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00242] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00243] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00244] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00245] s is an integer of 0, 1, 2, or 3; and

[00246] n is an integer of 0, 1, 2, 3, or 4.

[00247] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00248] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted

acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl. In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00249] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is $-OPO_3WY$. In some embodiments, R_7 is $-OCH_2PO_4WY$. In some embodiments, R_7 is $-OCH_2PO_4Z$. In some embodiments, R_7 is $-OPO_3Z$.

[00250] In some embodiments, R_8 is hydrogen. In some embodiments, R_8 is hydroxyl. In some embodiments, R_8 is carboxaldehyde. In some embodiments, R_8 is unsubstituted amine. In some embodiments, R_8 is substituted amine. In some embodiments, R_8 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_8 is substituted C_1-C_{10} alkyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_8 is substituted C_2-C_{10} alkynyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_8 is substituted C_2-C_{10} alkenyl. In some embodiments, R_8 is carboxyl. In some embodiments, R_8 is unsubstituted carbohydrate. In some embodiments, R_8 is substituted carbohydrate. In some embodiments, R_8 is unsubstituted ester. In some embodiments, R_8 is substituted ester. In some embodiments, R_8 is unsubstituted acyloxy. In some embodiments, R_8 is substituted acyloxy. In some embodiments, R_8 is nitro. In some embodiments, R_8 is halogen. In some embodiments, R_8 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_8 is substituted C_1-C_{10} aliphatic acyl. In some

embodiments, $R_8$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is unsubstituted alkoxy. In some embodiments, R_8 is substituted alkoxy. In some embodiments, R_8 is unsubstituted aryl. In some embodiments, R_8 is substituted aryl. In some embodiments, R_8 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is unsubstituted heteroaryl, In some embodiments, R_8 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is $-OPO_3WY$. In some embodiments, R_8 is $-OCH_2PO_4WY$. In some embodiments, R_8 is $-OCH_2PO_4Z$. In some embodiments, R_8 is $-OPO_3Z$.

[00251] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is $-OPO_3WY$. In some embodiments, R_9 is $-OCH_2PO_4WY$. In some embodiments, R_9 is $-OCH_2PO_4Z$. In some embodiments, R_9 is $-OPO_3Z$.

[00252] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate l. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted

heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is -PO_3WY. In some embodiments, R_{16} is -CH_2PO_4WY. In some embodiments, R_{16} is -CH_2PO_4Z. In some embodiments, R_{16} is -PO_3Z.

[00253] In some embodiments, R_{17} is hydrogen. In some embodiments, R_{17} is hydroxy. In some embodiments, R_{17} is carboxaldehyde. In some embodiments, R_{17} is unsubstituted amine. In some embodiments, R_{17} is substituted amine. In some embodiments, R_{17} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is carboxyl. In some embodiments, R_{17} is unsubstituted carbohydrate. In some embodiments, R_{17} is substituted carbohydrate. In some embodiments, R_{17} is unsubstituted ester. In some embodiments, R_{17} is substituted ester. In some embodiments, R_{17} is unsubstituted acyloxy. In some embodiments, R_{17} is substituted acyloxy. In some embodiments, R_{17} is nitro. In some embodiments, R_{17} is halogen. In some embodiments, R_{17} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} alkylaryl acyl. n some embodiments, R_{17} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is unsubstituted alkoxy. In some embodiments, R_{17} is substituted alkoxy. In some embodiments, R_{17} is unsubstituted aryl. In some embodiments, R_{17} is substituted aryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is unsubstituted heteroaryl. In some embodiments, R_{17} is substituted heteroaryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is -OPO_3WY. In some embodiments, R_{17} is -OCH_2PO_4WY. In some embodiments, R_{17} is -OCH_2PO_4Z. In some embodiments, R_{17} is -OPO_3Z.

[00254] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18}

is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00255] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00256] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00257] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

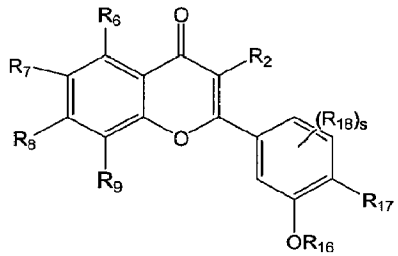
[00258] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00259] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00260] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00261] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00262] In various embodiments of the invention, the pyrone analog is of Formula VII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula VII

[00263] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00264] R_6, R_7, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00265] R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00266] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

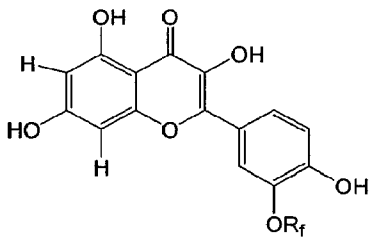
[00267] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic

acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00268] s is an integer of 0, 1, 2, or 3;

[00269] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00270] wherein the compound of Formula VII is not the compound of Formula A:



Formula A

[00271] wherein R_f is hydrogen; and

[00272] wherein the compound of Formula VII is not the compound wherein:

[00273] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00274] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00275] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- nitro;

[00276] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00277] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00278] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00279] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00280] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- methoxy;

[00281] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{17} is hydroxy, and s is 0;

[00282] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is methoxy, and s is 0;

[00283] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00284] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00285] R_2 is hydroxy, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00286] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00287] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00288] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0; or

[00289] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy.

[00290] In some embodiments, the compound of Formula VII is not the compound of Formula A wherein R_f is PO_3K_2.

[00291] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00292] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00293] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl, In some embodiments, R_6 is unsubstituted

C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00294] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl. In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is $-OPO_3WY$. In some embodiments, R_7 is $-OCH_2PO_4WY$. In some embodiments, R_7 is $-OCH_2PO_4Z$. In some embodiments, R_7 is $-OPO_3Z$.

[00295] In some embodiments, R_8 is hydrogen. In some embodiments, R_8 is hydroxyl. In some embodiments, R_8 is carboxaldehyde. In some embodiments, R_8 is unsubstituted amine. In some embodiments, R_8 is substituted amine. In some embodiments, R_8 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_8 is substituted C_1-C_{10} alkyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_8 is substituted C_2-C_{10} alkynyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_8 is substituted C_2-C_{10} alkenyl. In some embodiments, R_8 is carboxyl. In some embodiments, R_8 is unsubstituted carbohydrate. In some embodiments, R_8 is substituted carbohydrate. In some embodiments, R_8 is unsubstituted ester. In some embodiments, R_8 is substituted ester. In some embodiments, R_8 is unsubstituted acyloxy. In some embodiments, R_8 is substituted acyloxy. In some embodiments, R_8 is nitro. In some embodiments, R_8 is halogen. In some embodiments, R_8 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_8 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, $R_8$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is unsubstituted alkoxy. In some embodiments, R_8 is substituted alkoxy. In some embodiments, R_8 is unsubstituted aryl. In some embodiments, R_8 is substituted aryl. In some embodiments, R_8 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is unsubstituted heteroaryl, In some embodiments, R_8 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is

-OPO_3WY. In some embodiments, R_8 is -OCH_2PO_4WY. In some embodiments, R_8 is -OCH_2PO_4Z. In some embodiments, R_8 is -OPO_3Z.

[00296] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is -OPO_3WY. In some embodiments, R_9 is -OCH_2PO_4WY. In some embodiments, R_9 is -OCH_2PO_4Z. In some embodiments, R_9 is -OPO_3Z.

[00297] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is -PO_3WY. In some embodiments, R_{16} is -CH_2PO_4WY. In some embodiments, R_{16} is -CH_2PO_4Z. In some embodiments, R_{16} is -PO_3Z.

[00298] In some embodiments, R_{17} is hydrogen. In some embodiments, R_{17} is hydroxy. In some embodiments, R_{17} is carboxaldehyde. In some embodiments, R_{17} is unsubstituted amine. In some embodiments, R_{17} is substituted amine. In some embodiments, R_{17} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is carboxyl. In some

embodiments, R_{17} is unsubstituted carbohydrate. In some embodiments, R_{17} is substituted carbohydrate. In some embodiments, R_{17} is unsubstituted ester. In some embodiments, R_{17} is substituted ester. In some embodiments, R_{17} is unsubstituted acyloxy. In some embodiments, R_{17} is substituted acyloxy. In some embodiments, R_{17} is nitro. In some embodiments, R_{17} is halogen. In some embodiments, R_{17} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} alkylaryl acyl. n some embodiments, R_{17} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is unsubstituted alkoxy. In some embodiments, R_{17} is substituted alkoxy. In some embodiments, R_{17} is unsubstituted aryl. In some embodiments, R_{17} is substituted aryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is unsubstituted heteroaryl. In some embodiments, R_{17} is substituted heteroaryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is $-OPO_3WY$. In some embodiments, R_{17} is $-OCH_2PO_4WY$. In some embodiments, R_{17} is $-OCH_2PO_4Z$. In some embodiments, R_{17} is $-OPO_3Z$.

[00299] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00300] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

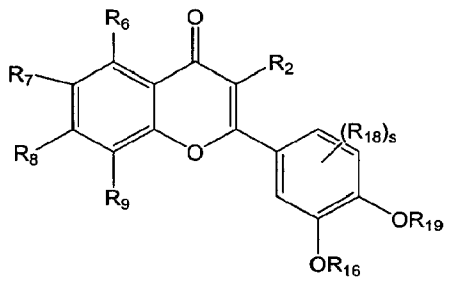
[00301] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted

carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00302] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00303] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00304] In other embodiments of the invention, the pyrone analog of the invention is a compound of Formula VIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula VIII

[00305] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00306] R_6, R_7, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00307] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

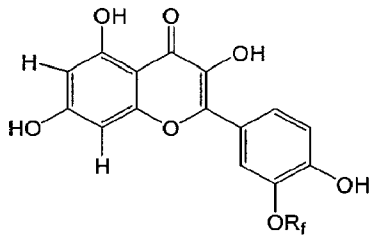
[00308] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00309] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00310] s is an integer of 0, 1, 2, or 3; and

[00311] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00312] wherein the compound of Formula VIII is not the compound of Formula A:



Formula A

[00313] wherein R_f is hydrogen; and

[00314] wherein the compound of Formula VII is not the compound wherein:

[00315] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00316] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00317] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- nitro;

[00318] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00319] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00320] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00321] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00322] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- methoxy;

[00323] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{17} is hydroxy, and s is 0;

[00324] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is methoxy, and s is 0;

[00325] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00326] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00327] R_2 is hydroxy, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00328] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00329] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00330] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0; or

[00331] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy.

[00332] In some embodiments, the compound of Formula VIII is not the compound of Formula A wherein R_f is PO_3K_2.

[00333] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00334] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00335] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl, In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00336] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is $-OPO_3WY$. In some embodiments, R_7 is $-OCH_2PO_4WY$. In some embodiments, R_7 is $-OCH_2PO_4Z$. In some embodiments, R_7 is $-OPO_3Z$.

[00337] In some embodiments, R_8 is hydrogen. In some embodiments, R_8 is hydroxyl. In some embodiments, R_8 is carboxaldehyde. In some embodiments, R_8 is unsubstituted amine. In some embodiments, R_8 is substituted amine. In some embodiments, R_8 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_8 is substituted C_1-C_{10} alkyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_8 is substituted C_2-C_{10} alkynyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_8 is substituted C_2-C_{10} alkenyl. In some embodiments, R_8 is carboxyl. In some embodiments, R_8 is unsubstituted carbohydrate. In some embodiments, R_8 is substituted carbohydrate. In some embodiments, R_8 is unsubstituted ester. In some embodiments, R_8 is substituted ester. In some embodiments, R_8 is unsubstituted acyloxy. In some embodiments, R_8 is substituted acyloxy. In some embodiments, R_8 is nitro. In some embodiments, R_8 is halogen. In some embodiments, R_8 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_8 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, $R_8$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is unsubstituted alkoxy. In some embodiments, R_8 is substituted alkoxy. In some embodiments, R_8 is unsubstituted aryl. In some embodiments, R_8 is substituted aryl. In some embodiments, R_8 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is unsubstituted heteroaryl, In some embodiments, R_8 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is $-OPO_3WY$. In some embodiments, R_8 is $-OCH_2PO_4WY$. In some embodiments, R_8 is $-OCH_2PO_4Z$. In some embodiments, R_8 is $-OPO_3Z$.

[00338] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine.

In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is $-OPO_3WY$. In some embodiments, R_9 is $-OCH_2PO_4WY$. In some embodiments, R_9 is $-OCH_2PO_4Z$. In some embodiments, R_9 is $-OPO_3Z$.

[00339] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00340] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some

embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00341] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

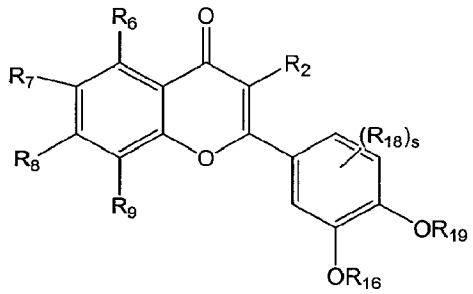
[00342] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

[00343] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00344] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00345] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00346] In some embodiments of the invention, the pyrone analog is of Formula IX or a pharmaceutically/veterinarily acceptable salt thereof:



Formula IX

[00347] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00348] R_6, R_7, R_8, and R_9 are independently hydrogen, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00349] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

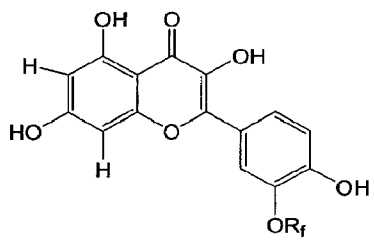
[00350] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00351] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00352] s is an integer of 0, 1, 2, or 3;

[00353] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00354] wherein the compound of Formula IX is not the compound of Formula A:



Formula A

[00355] wherein R_f is hydrogen; and

[00356] wherein the compound of Formula IX is not the compound wherein:

[00357] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00358] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00359] R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- nitro;

[00360] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00361] R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

[00362] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00363] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00364] R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- methoxy;

[00365] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{17} is hydroxy, and s is 0;

[00366] R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is methoxy, and s is 0;

[00367] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00368] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00369] R_2 is hydroxy, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00370] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

[00371] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

[00372] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0; or

[00373] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy.

[00374] In some embodiments, the compound of Formula VIII is not the compound of Formula A wherein R_f is PO_3K_2.

[00375] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00376] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is

substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00377] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl. In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00378] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl.

In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is $-OPO_3WY$. In some embodiments, R_7 is $-OCH_2PO_4WY$. In some embodiments, R_7 is $-OCH_2PO_4Z$. In some embodiments, R_7 is $-OPO_3Z$.

[00379] In some embodiments, R_8 is hydrogen. In some embodiments, R_8 is carboxaldehyde. In some embodiments, R_8 is unsubstituted amine. In some embodiments, R_8 is substituted amine. In some embodiments, R_8 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_8 is substituted C_1-C_{10} alkyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_8 is substituted C_2-C_{10} alkynyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_8 is substituted C_2-C_{10} alkenyl. In some embodiments, R_8 is carboxyl. In some embodiments, R_8 is unsubstituted carbohydrate. In some embodiments, R_8 is substituted carbohydrate. In some embodiments, R_8 is unsubstituted ester. In some embodiments, R_8 is substituted ester. In some embodiments, R_8 is unsubstituted acyloxy. In some embodiments, R_8 is substituted acyloxy. In some embodiments, R_8 is nitro. In some embodiments, R_8 is halogen. In some embodiments, R_8 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_8 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, $R_8$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is unsubstituted alkoxy. In some embodiments, R_8 is substituted alkoxy. In some embodiments, R_8 is unsubstituted aryl. In some embodiments, R_8 is substituted aryl. In some embodiments, R_8 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is unsubstituted heteroaryl, In some embodiments, R_8 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is $-OPO_3WY$. In some embodiments, R_8 is $-OCH_2PO_4WY$. In some embodiments, R_8 is $-OCH_2PO_4Z$. In some embodiments, R_8 is $-OPO_3Z$.

[00380] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy.

In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is $-OPO_3WY$. In some embodiments, R_9 is $-OCH_2PO_4WY$. In some embodiments, R_9 is $-OCH_2PO_4Z$. In some embodiments, R_9 is $-OPO_3Z$.

[00381] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00382] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00383] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

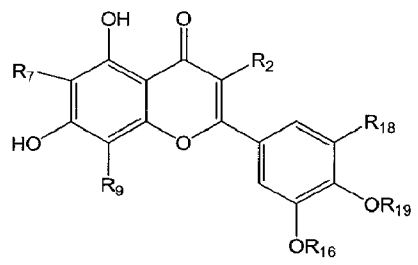
[00384] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

[00385] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00386] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00387] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00388] In some embodiments of the invention, the pyrone analog is of Formula X or a pharmaceutically/veterinarily acceptable salt thereof:



Formula X

[00389] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00390] R_7 and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00391] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

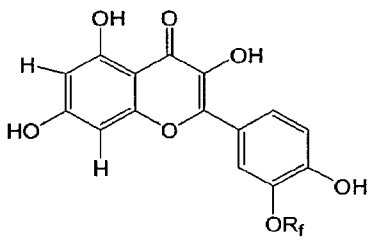
[00392] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00393] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00394] s is an integer of 0, 1, 2, or 3; and

[00395] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00396] wherein the compound of Formula X is not the compound of Formula A:



Formula A

[00397] wherein R_f is hydrogen; and

[00398] wherein the compound of Formula X is not the compound wherein:

[00399] R_2 is hydrogen, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydrogen;

[00400] R_2 is hydrogen, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydroxy;

[00401] R_2 is hydrogen, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is methoxy;

[00402] R_2 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{19} is hydrogen, and R_{18} is hydrogen; or

[00403] R_2 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is methyl, and R_{18} is hydrogen.

[00404] In some embodiments, the compound of Formula X is not the compound of Formula A wherein R_f is PO_3K_2.

[00405] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments,

at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00406] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00407] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is

-OPO_3WY. In some embodiments, R_7 is -OCH_2PO_4WY. In some embodiments, R_7 is -OCH_2PO_4Z. In some embodiments, R_7 is -OPO_3Z.

[00408] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is -OPO_3WY. In some embodiments, R_9 is -OCH_2PO_4WY. In some embodiments, R_9 is -OCH_2PO_4Z. In some embodiments, R_9 is -OPO_3Z.

[00409] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is -PO_3WY. In some embodiments, R_{16} is -CH_2PO_4WY. In some embodiments, R_{16} is -CH_2PO_4Z. In some embodiments, R_{16} is -PO_3Z.

[00410] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some

embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00411] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00412] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

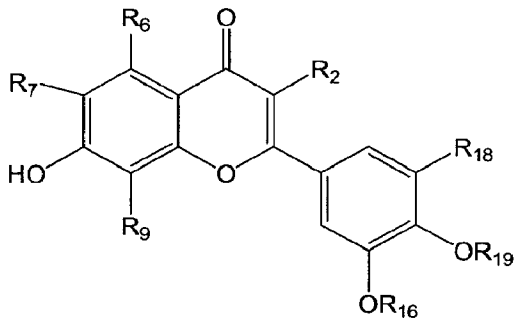
[00413] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00414] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted

carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00415] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00416] In other embodiments of the invention, the pyrone analogs of the invention are of Formula XI or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XI

[00417] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00418] R_6, R_7, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00419] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

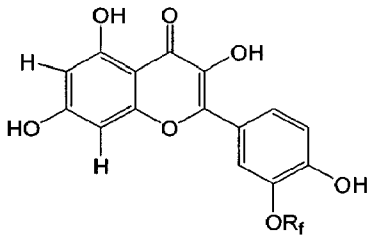
[00420] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00421] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00422] s is an integer of 0, 1, 2, or 3; and

[00423] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00424] wherein the compound of Formula XI is not the compound of Formula A:



Formula A

[00425] wherein R_f is hydrogen; and

[00426] wherein the compound of Formula XI is not the compound wherein:

[00427] R_2 is hydrogen, R_6 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{18} is hydrogen, and R_{19} is hydrogen;

[00428] R_2 is hydrogen, R_6 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydroxy;

[00429] R_2 is hydrogen, R_6 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is methoxy;

[00430] R_2 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{19} is hydrogen, and R_{18} is hydrogen;

[00431] R_2 is hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is methyl, and R_{18} is hydrogen;

[00432] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydrogen;

[00433] R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydroxy;

[00434] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydrogen; or

[00435] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydroxy.

[00436] In some embodiments, the compound of Formula XI is not the compound of Formula A wherein R_f is PO_3K_2.

[00437] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00438] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl.

In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00439] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl. In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00440] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments, R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is

substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is -OPO_3WY. In some embodiments, R_7 is -OCH_2PO_4WY. In some embodiments, R_7 is -OCH_2PO_4Z. In some embodiments, R_7 is -OPO_3Z.

[00441] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is -OPO_3WY. In some embodiments, R_9 is -OCH_2PO_4WY. In some embodiments, R_9 is -OCH_2PO_4Z. In some embodiments, R_9 is -OPO_3Z.

[00442] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is -PO_3WY. In some embodiments, R_{16} is -CH_2PO_4WY. In some embodiments, R_{16} is -CH_2PO_4Z. In some embodiments, R_{16} is -PO_3Z.

[00443] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00444] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00445] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

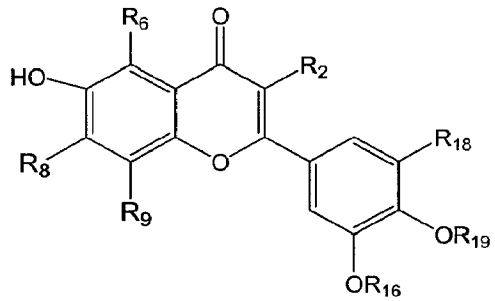
[00446] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted

carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00447] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00448] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00449] In other embodiments of the invention, the pyrone analog is of Formula XII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XII

[00450] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00451] R_6, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00452] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00453] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00454] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00455] s is an integer of 0, 1, 2, or 3;

[00456] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00457] wherein the compound of Formula XII is not the compound wherein

[00458] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydrogen;

[00459] R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydroxy; or

[00460] R_2 is hydroxy, R_6, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{19} is hydrogen, and R_{18} is hydrogen.

[00461] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00462] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00463] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is

substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl, In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00464] In some embodiments, R_8 is hydrogen. In some embodiments, R_8 is hydroxyl. In some embodiments, R_8 is carboxaldehyde. In some embodiments, R_8 is unsubstituted amine. In some embodiments, R_8 is substituted amine. In some embodiments, R_8 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_8 is substituted C_1-C_{10} alkyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_8 is substituted C_2-C_{10} alkynyl. In some embodiments, R_8 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_8 is substituted C_2-C_{10} alkenyl. In some embodiments, R_8 is carboxyl. In some embodiments, R_8 is unsubstituted carbohydrate. In some embodiments, R_8 is substituted carbohydrate. In some embodiments, R_8 is unsubstituted ester. In some embodiments, R_8 is substituted ester. In some embodiments, R_8 is unsubstituted acyloxy. In some embodiments, R_8 is substituted acyloxy. In some embodiments, R_8 is nitro. In some embodiments, R_8 is halogen. In some embodiments, R_8 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_8 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, $R_8$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_8 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_8 is unsubstituted alkoxy. In some embodiments, R_8 is substituted alkoxy. In some embodiments, R_8 is unsubstituted aryl. In some embodiments, R_8 is substituted aryl. In some embodiments, R_8 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_8 is unsubstituted heteroaryl, In some embodiments, R_8 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_8 is $-OPO_3WY$. In some embodiments, R_8 is $-OCH_2PO_4WY$. In some embodiments, R_8 is $-OCH_2PO_4Z$. In some embodiments, R_8 is $-OPO_3Z$.

[00465] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In

some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is $-OPO_3WY$. In some embodiments, R_9 is $-OCH_2PO_4WY$. In some embodiments, R_9 is $-OCH_2PO_4Z$. In some embodiments, R_9 is $-OPO_3Z$.

[00466] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00467] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00468] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some

embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

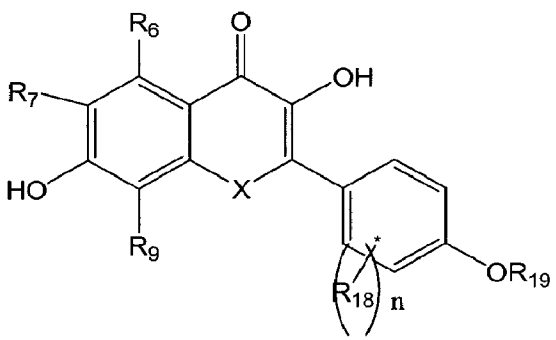
[00469] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

[00470] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00471] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00472] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00473] In other embodiments of the invention, the pyrone analog is of Formula XIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XIII

[00474] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

[00475] wherein R_2 is hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

[00476] R_6, R_7, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

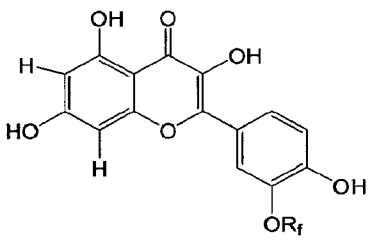
[00477] each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

[00478] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, -PO_3WY, -CH_2PO_4WY, -CH_2PO_4Z or -PO_3Z;

[00479] n is an integer of 0, 1, 2, 3, or 4; and

[00480] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00481] wherein the compound of Formula XIII is not the compound of Formula A:



Formula A

[00482] wherein R_f is hydrogen; and

[00483] wherein the compound of Formula XIII is not the compound wherein:

[00484] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, n is 2, and a first R_{18} is 3'-hydroxy, R_{19} is hydrogen, and a second R_{18} is 5'-hydroxy; or

[00485] R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, n is 1, R_{19} is hydrogen, and R_{18} is 3'-hydroxy.

[00486] In some embodiments, the compound of Formula XIII is not the compound of Formula A wherein R_f is PO_3K_2.

[00487] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2

is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00488] In some embodiments, R_6 is hydrogen. In some embodiments, R_6 is hydroxyl. In some embodiments, R_6 is carboxaldehyde. In some embodiments, R_6 is unsubstituted amine. In some embodiments, R_6 is substituted amine. In some embodiments, R_6 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_6 is substituted C_1-C_{10} alkyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_6 is substituted C_2-C_{10} alkynyl. In some embodiments, R_6 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_6 is substituted C_2-C_{10} alkenyl. In some embodiments, R_6 is carboxyl. In some embodiments, R_6 is unsubstituted carbohydrate. In some embodiments, R_6 is substituted carbohydrate. In some embodiments, R_6 is unsubstituted ester. In some embodiments, R_6 is substituted ester. In some embodiments, R_6 is unsubstituted acyloxy. In some embodiments, R_6 is substituted acyloxy. In some embodiments, R_6 is nitro. In some embodiments, R_6 is halogen. In some embodiments, R_6 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_6 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_6 is unsubstituted alkoxy. In some embodiments, R_6 is substituted alkoxy. In some embodiments, R_6 is unsubstituted aryl. In some embodiments, R_6 is substituted aryl. In some embodiments, R_6 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_6 is unsubstituted heteroaryl, In some embodiments, R_6 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_6 is $-OPO_3WY$. In some embodiments, R_6 is $-OCH_2PO_4WY$. In some embodiments, R_6 is $-OCH_2PO_4Z$. In some embodiments, R_6 is $-OPO_3Z$.

[00489] In some embodiments, R_7 is hydrogen. In some embodiments, R_7 is hydroxyl. In some embodiments, R_7 is carboxaldehyde. In some embodiments, R_7 is unsubstituted amine. In some embodiments, R_7 is substituted amine. In some embodiments, R_7 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_7 is substituted C_1-C_{10} alkyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_7 is substituted C_2-C_{10} alkynyl. In some embodiments, R_7 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_7 is substituted C_2-C_{10} alkenyl. In some embodiments, R_7 is carboxyl. In some embodiments, R_7 is unsubstituted carbohydrate. In some embodiments,

R_7 is substituted carbohydrate. In some embodiments, R_7 is unsubstituted ester. In some embodiments, R_7 is substituted ester. In some embodiments, R_7 is unsubstituted acyloxy. In some embodiments, R_7 is substituted acyloxy. In some embodiments, R_7 is nitro. In some embodiments, R_7 is halogen. In some embodiments, R_7 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_7 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_7 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, $R_7$is unsubstituted alkoxy. In some embodiments, R_7 is substituted alkoxy. In some embodiments, R_7 is unsubstituted aryl. In some embodiments, R_7 is substituted aryl. In some embodiments, R_7 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_7 is unsubstituted heteroaryl, In some embodiments, R_7 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_7 is $-OPO_3WY$. In some embodiments, R_7 is $-OCH_2PO_4WY$. In some embodiments, R_7 is $-OCH_2PO_4Z$. In some embodiments, R_7 is $-OPO_3Z$.

[00490] In some embodiments, R_9 is hydrogen. In some embodiments, R_9 is hydroxyl. In some embodiments, R_9 is carboxaldehyde. In some embodiments, R_9 is unsubstituted amine. In some embodiments, R_9 is substituted amine. In some embodiments, R_9 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_9 is substituted C_1-C_{10} alkyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_9 is substituted C_2-C_{10} alkynyl. In some embodiments, R_9 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_9 is substituted C_2-C_{10} alkenyl. In some embodiments, R_9 is carboxyl. In some embodiments, R_9 is unsubstituted carbohydrate. In some embodiments, R_9 is substituted carbohydrate. In some embodiments, R_9 is unsubstituted ester. In some embodiments, R_9 is substituted ester. In some embodiments, R_9 is unsubstituted acyloxy. In some embodiments, R_9 is substituted acyloxy. In some embodiments, R_9 is nitro. In some embodiments, R_9 is halogen. In some embodiments, R_9 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_9 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, $R_9$is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_9 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_9 is unsubstituted alkoxy. In some embodiments, R_9 is substituted alkoxy. In some embodiments, R_9 is unsubstituted aryl. In some embodiments, R_9 is substituted aryl. In some embodiments, R_9 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_9 is unsubstituted heteroaryl, In some embodiments, R_9 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_9 is $-OPO_3WY$. In some embodiments, R_9 is $-OCH_2PO_4WY$. In some embodiments, R_9 is $-OCH_2PO_4Z$. In some embodiments, R_9 is $-OPO_3Z$.

[00491] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments,

R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00492] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

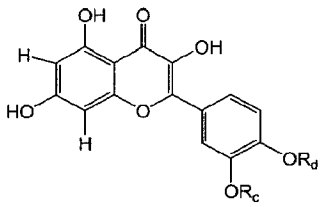
[00493] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00494] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

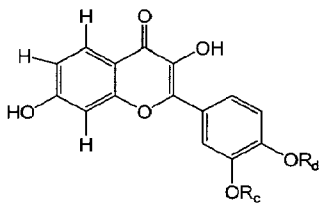
[00495] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00496] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

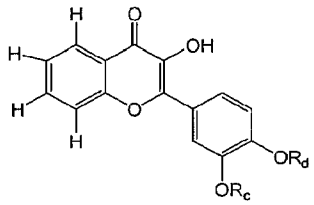
[00497] In some embodiments of the invention, compounds of the following Formulae VIII-A, VIII-B, and VIII-C, are disclosed, where each instance of R_c and R_d is independently hydrogen, $-OPO_3WY$, $-OPO_3Z$, $-OCH_2OPOWY$, or $-OCH_2OPO_3Z$, where W and Y are hydrogen, methyl, ethyl, alkyl, carbohydrate, lithium, sodium or potassium and Z is calcium, magnesium or iron .



Formula VIII-A



Formula VIII-B

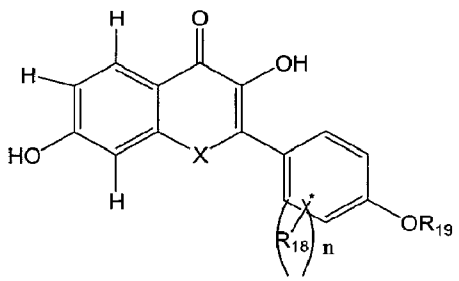


Formula VIII-C

[00498] In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-OPO_3WY$ and R_d is hydrogen. In some embodiments, the compound of Formula VIII-A is not the compound wherein R_c is $-OPO_3K_2$ and R_d is hydrogen.

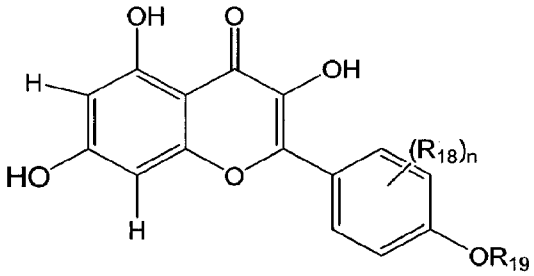
[00499] In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-OPO_3WY$ and R_d is $-OPO_3WY$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is a mixture of hydrogen and $-OPO_3WY$ and R_d is $-OPO_3WY$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is hydrogen and R_d is a mixture of hydrogen and $-OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-OPO_3Z$ and R_d is hydrogen. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-OPO_3Z$ and R_d is $-OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is a mixture of hydrogen and $-OPO_3Z$ and R_d is $-OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is hydrogen and R_d is a mixture of hydrogen and $-OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-CH_2OPO_3Z$ and R_d is hydrogen. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is $-CH_2OPO_3Z$ and R_d is $-CH_2OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is a mixture of hydrogen and $-CH_2OPO_3Z$ and R_d is $-CH_2OPO_3Z$. In some embodiments of the invention, for a compound of Formulae VIII-A, VIII-B, or VIII-C, R_c is hydrogen and R_d is a mixture of hydrogen and $-CH_2OPO_3Z$.

[00500] In some embodiments, the pyrone analog of Formula XIII is of Formula XIV:



Formula XIV

[00501] In some embodiments the pyrone analog of the invention is of Formula XV or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XV

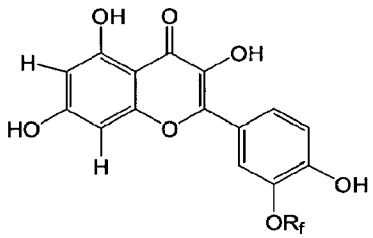
[00502] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00503] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00504] n is an integer of 0, 1, 2, 3, or 4; and

[00505] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00506] wherein the compound of Formula XV is not the compound of Formula A:



Formula A

[00507] wherein R_f is hydrogen.

[00508] In some embodiments, the compound of Formula XV is not the compound of Formula A wherein R_f is PO_3K_2.

[00509] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00510] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some

embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00511] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

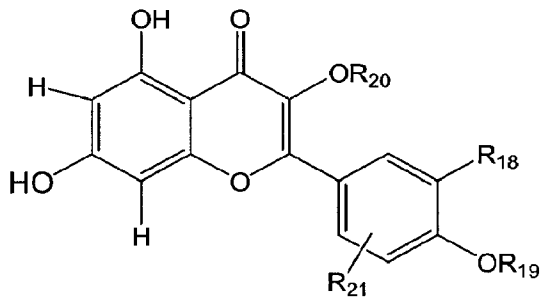
[00512] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00513] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00514] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00515] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00516] In some embodiments, the pyrone analog of the invention is a compound of Formula XVI or a pharmaceutically/veterinarily acceptable salt thereof:



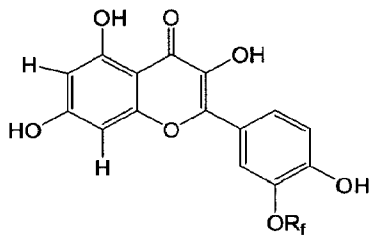
Formula XVI

[00517] wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00518] R_{19} and R_{20} are independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

[00519] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00520] wherein the compound of Formula XVI is not the compound of Formula A:



Formula A

[00521] wherein R_f is hydrogen.

[00522] In some embodiments, the compound of Formula XVI is not the compound of Formula A wherein R_f is PO_3K_2.

[00523] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} or R_{21} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} or R_{21} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00524] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10}

alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00525] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00526] In some embodiments, R_{20} is hydrogen. In some embodiments, R_{20} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{20} is substituted C_1-C_{10} alkyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is unsubstituted carbohydrate. In some embodiments, R_{20} is substituted carbohydrate. In some embodiments, R_{20} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is unsubstituted aryl. In some embodiments, R_{20} is substituted aryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is substituted C_3-C_{10}

heterocyclyl. In some embodiments, R_{20} is unsubstituted heteroaryl. In some embodiments, R_{20} is substituted heteroaryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is $-PO_3WY$. In some embodiments, R_{20} is $-CH_2PO_4WY$. In some embodiments, R_{20} is $-CH_2PO_4Z$. In some embodiments, R_{20} is $-PO_3Z$.

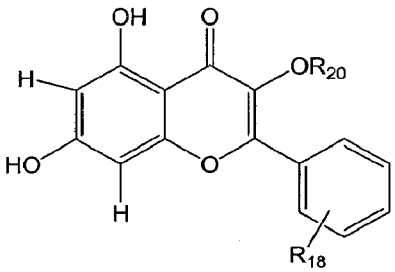
[00527] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00528] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00529] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00530] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00531] In some embodiments, the pyrone analog of the invention is a compound of Formula XVII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XVII

[00532] wherein R_{18} is hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00533] R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

[00534] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation.

[00535] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00536] In some embodiments, R_{20} is hydrogen. In some embodiments, R_{20} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{20} is substituted C_1-C_{10} alkyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkynyl. In some

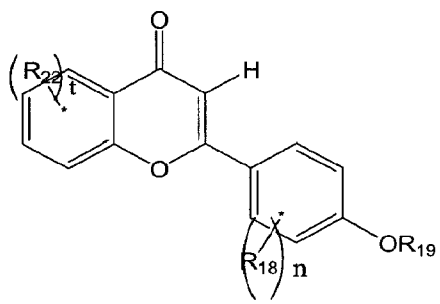
embodiments, R_{20} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is unsubstituted carbohydrate. In some embodiments, R_{20} is substituted carbohydrate. In some embodiments, R_{20} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is unsubstituted aryl. In some embodiments, R_{20} is substituted aryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is unsubstituted heteroaryl. In some embodiments, R_{20} is substituted heteroaryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is $-PO_3WY$. In some embodiments, R_{20} is $-CH_2PO_4WY$. In some embodiments, R_{20} is $-CH_2PO_4Z$. In some embodiments, R_{20} is $-PO_3Z$.

[00537] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00538] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00539] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00540] In some embodiments, the pyrone analog of the invention is a compound of Formula XVIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XVIII

[00541] wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

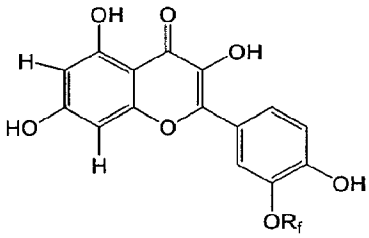
[00542] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00543] n is an integer of 0, 1, 2, 3, or 4;

[00544] t is an integer of 0, 1, 2, 3, or 4; and

[00545] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

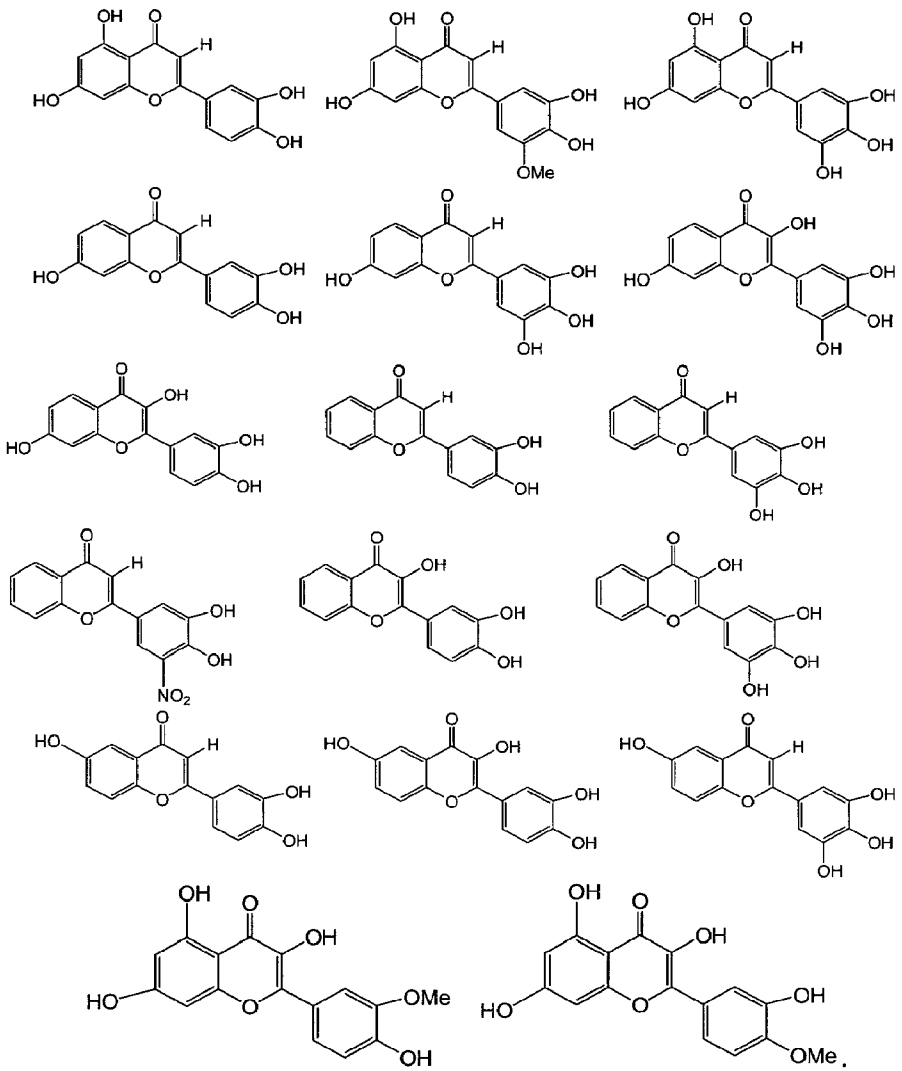
[00546] wherein the compound of Formula XVIII is not the compound of Formula A:



Formula A

[00547] wherein R_f is hydrogen; and

[00548] wherein the compound of Formula XVIII is not the compound of the following formulae:



[00549] In some embodiments, the compound of Formula XVIII is not the compound of Formula A wherein R_f is PO_3K_2.

[00550] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00551] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00552] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00553] In some embodiments, R_{22} is hydrogen. In some embodiments, R_{22} is hydroxy. In some embodiments, R_{22} is carboxaldehyde. In some embodiments, R_{22} is unsubstituted amine. In some embodiments, R_{22} is substituted amine. In some embodiments, R_{22} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10}

alkenyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{22} is carboxyl. In some embodiments, R_{22} is unsubstituted carbohydrate. In some embodiments, R_{22} is substituted carbohydrate. In some embodiments, R_{22} is unsubstituted ester. In some embodiments, R_{22} is substituted ester. In some embodiments, R_{22} is unsubstituted acyloxy. In some embodiments, R_{22} is substituted acyloxy. In some embodiments, R_{22} is nitro. In some embodiments, R_{22} is halogen. In some embodiments, R_{22} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is unsubstituted alkoxy. In some embodiments, R_{22} is substituted alkoxy. In some embodiments, R_{22} is unsubstituted aryl. In some embodiments, R_{22} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is unsubstituted heteroaryl. In some embodiments, R_{22} is substituted heteroaryl. In some embodiments, R_{22} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is $-OPO_3WY$. In some embodiments, R_{22} is $-OCH_2PO_4WY$. In some embodiments, R_{22} is $-OCH_2PO_4Z$. In some embodiments, R_{22} is $-OPO_3Z$.

[00554] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

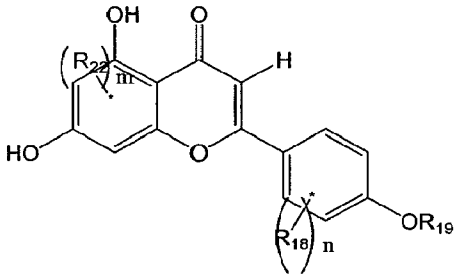
[00555] In some embodiments, t is an integer of 0. In some embodiments, t is an integer of 1. In some embodiments, t is an integer of 2. In some embodiments, t is an integer of 3. In some embodiments, t is an integer of 4.

[00556] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00557] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00558] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00559] In some embodiments, the pyrone analog of the invention is a compound of Formula XIX or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XIX

[00560] wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

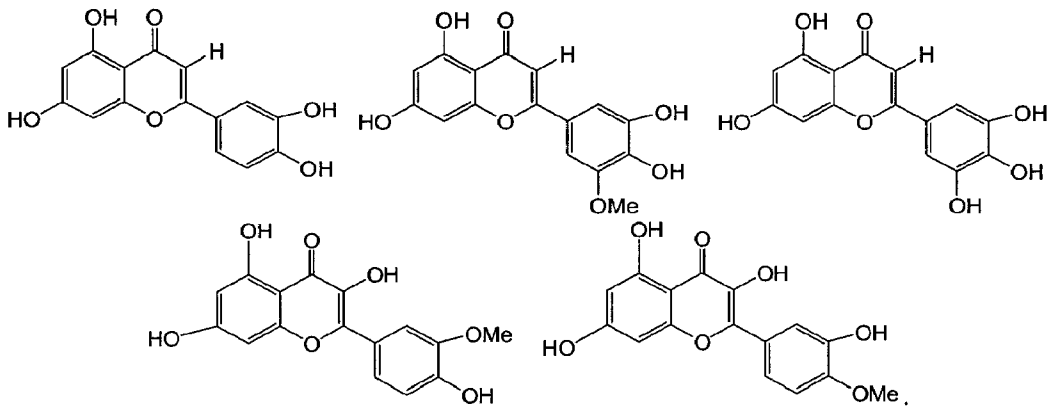
[00561] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00562] n is an integer of 0, 1, 2, 3, or 4;

[00563] m is an integer of 0, 1, or 2; and

[00564] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation, and

[00565] wherein the compound of Formula XIX is not one of the following compounds:



[00566] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00567] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments,

R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00568] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00569] In some embodiments, R_{22} is hydrogen. In some embodiments, R_{22} is hydroxy. In some embodiments, R_{22} is carboxaldehyde. In some embodiments, R_{22} is unsubstituted amine. In some embodiments, R_{22} is substituted amine. In some embodiments, R_{22} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{22} is carboxyl. In some embodiments, R_{22} is unsubstituted carbohydrate. In some embodiments, R_{22} is substituted carbohydrate. In some embodiments, R_{22} is unsubstituted ester. In some embodiments, R_{22} is substituted ester. In some embodiments, R_{22} is unsubstituted acyloxy. In some embodiments, R_{22} is substituted acyloxy. In some embodiments, R_{22} is nitro. In some embodiments, R_{22} is halogen. In some embodiments, R_{22} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is unsubstituted alkoxy. In some embodiments, R_{22} is substituted alkoxy. In some embodiments, R_{22} is unsubstituted aryl. In some embodiments, R_{22} is substituted aryl. In some embodiments, R_{18} is unsubstituted

C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is unsubstituted heteroaryl. In some embodiments, R_{22} is substituted heteroaryl. In some embodiments, R_{22} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is $-OPO_3WY$. In some embodiments, R_{22} is $-OCH_2PO_4WY$. In some embodiments, R_{22} is $-OCH_2PO_4Z$. In some embodiments, R_{22} is $-OPO_3Z$.

[00570] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

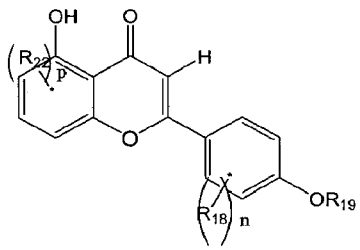
[00571] In some embodiments, m is an integer of 0. In some embodiments, m is an integer of 1. In some embodiments, m is an integer of 2.

[00572] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00573] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00574] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00575] In some embodiments, the pyrone analog of the invention is a compound of Formula XX or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XX

[00576] wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

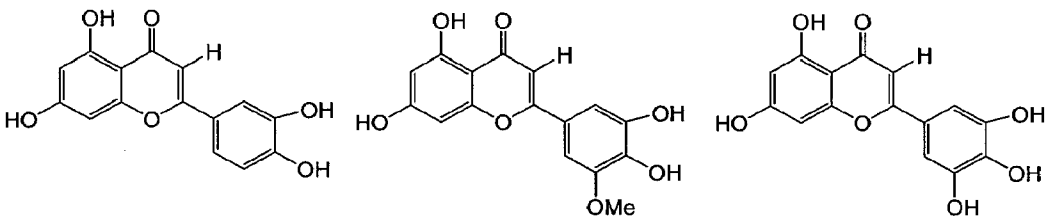
[00577] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

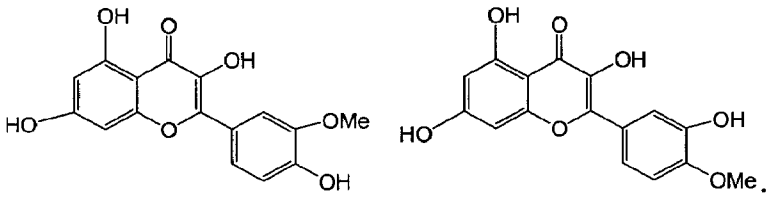
[00578] n is an integer of 0, 1, 2, 3, or 4;

[00579] p is an integer of 0, 1, 2 or 3;

[00580] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00581] wherein the compound of Formula XX is not one of the following compounds:





[00582] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00583] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00584] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some

embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00585] In some embodiments, R_{22} is hydrogen. In some embodiments, R_{22} is hydroxy. In some embodiments, R_{22} is carboxaldehyde. In some embodiments, R_{22} is unsubstituted amine. In some embodiments, R_{22} is substituted amine. In some embodiments, R_{22} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{22} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{22} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{22} is carboxyl. In some embodiments, R_{22} is unsubstituted carbohydrate. In some embodiments, R_{22} is substituted carbohydrate. In some embodiments, R_{22} is unsubstituted ester. In some embodiments, R_{22} is substituted ester. In some embodiments, R_{22} is unsubstituted acyloxy. In some embodiments, R_{22} is substituted acyloxy. In some embodiments, R_{22} is nitro. In some embodiments, R_{22} is halogen. In some embodiments, R_{22} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{22} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{22} is unsubstituted alkoxy. In some embodiments, R_{22} is substituted alkoxy. In some embodiments, R_{22} is unsubstituted aryl. In some embodiments, R_{22} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{22} is unsubstituted heteroaryl. In some embodiments, R_{22} is substituted heteroaryl. In some embodiments, R_{22} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{22} is $-OPO_3WY$. In some embodiments, R_{22} is $-OCH_2PO_4WY$. In some embodiments, R_{22} is $-OCH_2PO_4Z$. In some embodiments, R_{22} is $-OPO_3Z$.

[00586] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

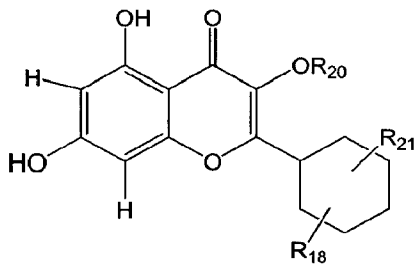
[00587] In some embodiments, p is an integer of 0. In some embodiments, p is an integer of 1. In some embodiments, p is an integer of 2. In some embodiments, p is an integer of 3.

[00588] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00589] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00590] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00591] In some embodiments, the pyrone analog of the invention is a compound of Formula XXI or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXI

[00592] wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00593] R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

[00594] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation.

[00595] In some embodiments of the invention, at least one of R_{187} or R_{21} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00596] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is

substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00597] In some embodiments, R_{20} is hydrogen. In some embodiments, R_{20} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{20} is substituted C_1-C_{10} alkyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is unsubstituted carbohydrate. In some embodiments, R_{20} is substituted carbohydrate. In some embodiments, R_{20} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is unsubstituted aryl. In some embodiments, R_{20} is substituted aryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is unsubstituted heteroaryl. In some embodiments, R_{20} is substituted heteroaryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is $-PO_3WY$. In some embodiments, R_{20} is $-CH_2PO_4WY$. In some embodiments, R_{20} is $-CH_2PO_4Z$. In some embodiments, R_{20} is $-PO_3Z$.

[00598] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments,

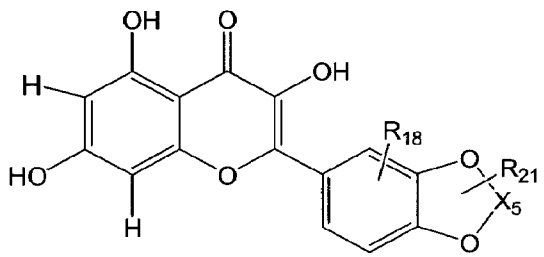
R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00599] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00600] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00601] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00602] In some embodiments, the pyrone analog of the invention is a compound of Formula XXII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXII

[00603] wherein X_5 is a C_1 to C_4 group, optionally interrupted by O, S, NR_{23}, or $NR_{23}R_{23}$ as valency permits, forming a ring which is aromatic or nonaromatic;

[00604] wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00605] each instance of R_{23} is independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, acyloxy, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, heteroaryl, C_5-C_{10}heterocyclyl, , C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00606] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, and a cation; and Z is a multivalent cation.

[00607] In some embodiments of the invention, at least one of R_{18} or R_{21} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00608] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10}

alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00609] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00610] In some embodiments, R_{23} is hydrogen. In some embodiments, R_{23} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{23} is substituted C_1-C_{10} alkyl. In some embodiments, R_{23} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{23} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{23} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{23} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{23} is unsubstituted acyloxy. In some embodiments, R_{23} is substituted acyloxy. In some embodiments, R_{23} is unsubstituted carbohydrate. In some

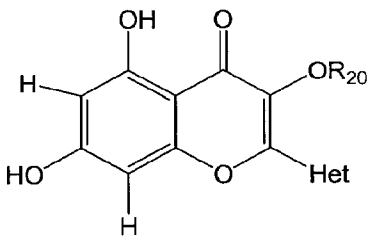
embodiments, R_{23} is substituted carbohydrate. In some embodiments, R_{23} is unsubstituted acyloxy. In some embodiments, R_{23} is substituted acyloxy. In some embodiments, R_{23} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{23} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{23} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{23} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{23} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{23} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{23} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{23} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{23} is unsubstituted alkoxy. In some embodiments, R_{23} is substituted alkoxy. In some embodiments, R_{23} is unsubstituted aryl. In some embodiments, R_{23} is substituted aryl. In some embodiments, R_{23} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{23} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{23} is unsubstituted heteroaryl. In some embodiments, R_{23} is substituted heteroaryl. In some embodiments, R_{23} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{23} is substituted C_3-C_{10}cycloalkyl.

[00611] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00612] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00613] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00614] In some embodiments, the pyrone analog of the invention is a compound of Formula XXIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXIII

[00615] wherein R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

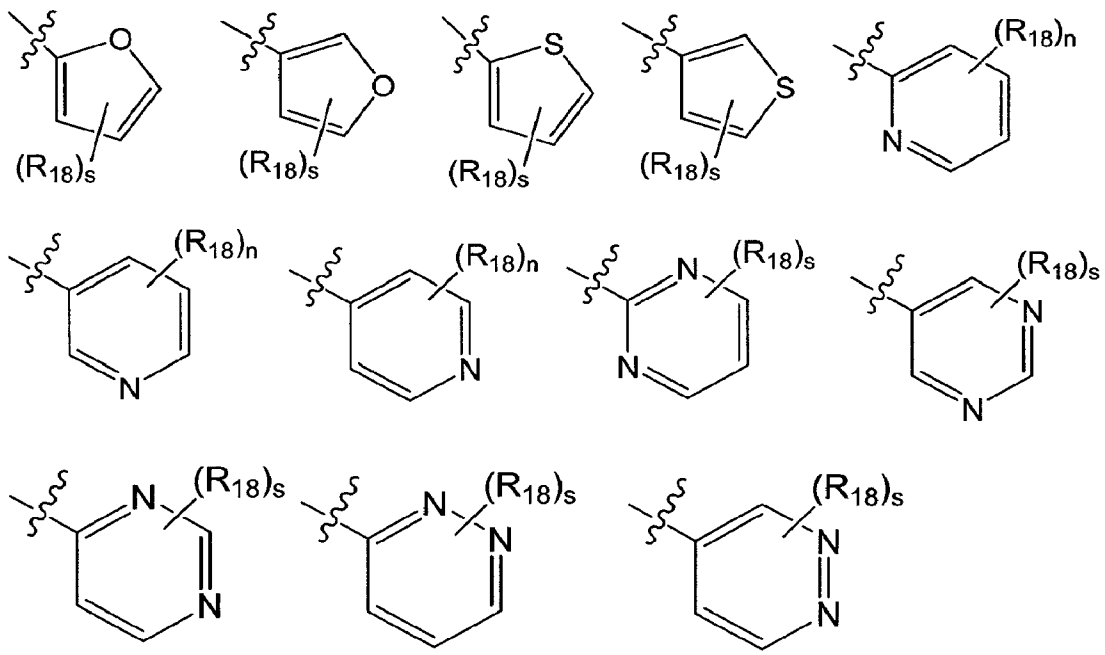
[00616] Het is a 3 to 10 membered optionally substituted monocyclic or bicyclic heteroaromatic or heteroalicyclic ring system containing 1, 2, 3, 4, or 5 heteroatoms selected from the group of O, S, and N, with the proviso that no two adjacent ring atoms are O or S, wherein the ring system is unsaturated, partially unsaturated or saturated, wherein any number of the ring atoms have substituents as valency permits which are hydrogen, hydroxyl,

carboxaldehyde, alkylcarboxaldehyde, imino, C_1-C_{10} alkyl, C_1-C_{10} alkynyl, C_1-C_{10} alkenyl, carboxyl, carbohydrate, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_5-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, heteroaryl, C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00617] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation.

[00618] In some embodiments, R_{20} is hydrogen. In some embodiments, R_{20} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{20} is substituted C_1-C_{10} alkyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{20} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{20} is unsubstituted carbohydrate. In some embodiments, R_{20} is substituted carbohydrate. In some embodiments, R_{20} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{20} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{20} is unsubstituted aryl. In some embodiments, R_{20} is substituted aryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{20} is unsubstituted heteroaryl. In some embodiments, R_{20} is substituted heteroaryl. In some embodiments, R_{20} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{20} is $-PO_3WY$. In some embodiments, R_{20} is $-CH_2PO_4WY$. In some embodiments, R_{20} is $-CH_2PO_4Z$. In some embodiments, R_{20} is $-PO_3Z$.

[00619] In some embodiments, Het is one of the following formulae:



[00620] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00621] s is an integer of 0, 1, 2, or 3; and

[00622] n is an integer of 0, 1, 2, 3, or 4.

[00623] In some embodiments of the invention, at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00624] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00625] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

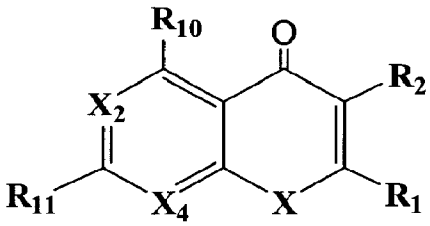
[00626] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

[00627] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

[00628] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00629] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00630] In some embodiments of the invention, the pyrone analog of Formula II is of Formula IV or a pharmaceutically/veterinarily acceptable salt thereof:



Formula IV

[00631] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

[00632] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

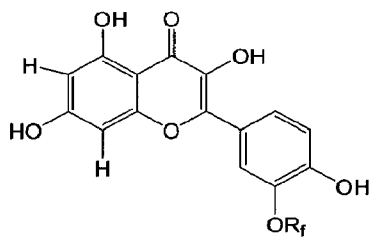
[00633] X_2 and X_4 are independently CR_5, O, S, or N;

[00634] each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00635] R_{10} and R_{11} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00636] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00637] wherein the compound of Formula IV is not the compound of Formula A:



Formula A

[00638] wherein R_f is hydrogen.

[00639] In some embodiments, the compound of Formula IV is not the compound of Formula A wherein R_f is PO_3K_2.

[00640] In some embodiments, X is O.

[00641] In other embodiments, X is S.

[00642] In yet other embodiments, X is NR'.

[00643] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

[00644] In some embodiments, X_2 is CR_5.

[00645] In other embodiments, X_2 is O.

[00646] In yet other embodiments, X_2 is S.

[00647] In further embodiments, X_2 is N.

[00648] In other embodiments, X_4 is CR_5.

[00649] In some embodiments, X_4 is O.

[00650] In yet other embodiments, X_4 is S.

[00651] In some embodiments, X_4 is N.

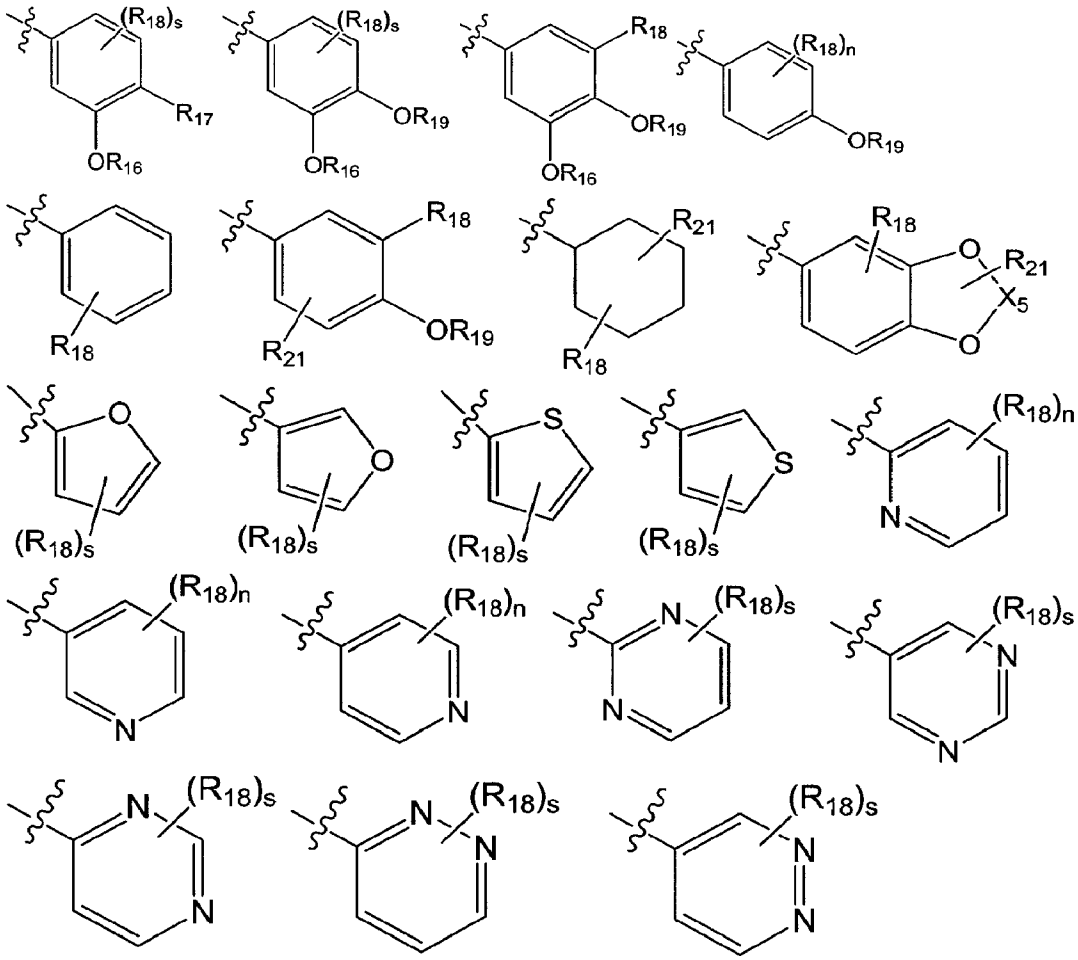
[00652] In some embodiments, at least one of X_2 or X_4 is N.

[00653] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is

substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00654] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00655] In various embodiments, R_1 is one of the following formulae:



[00656] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00657] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00658] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00659] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00660] s is an integer of 0, 1, 2, or 3; and

[00661] n is an integer of 0, 1, 2, 3, or 4.

[00662] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00663] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, $R_2$is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00664] In some embodiments, R_5 is hydrogen. In some embodiments, R_5 is hydroxyl. In some embodiments, R_5 is carboxaldehyde. In some embodiments, R_5 is unsubstituted amine. In some embodiments, R_5 is substituted amine. In some embodiments, R_5 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_5 is substituted C_1-C_{10} alkyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_5 is substituted C_2-C_{10} alkynyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, $R_5$is substituted C_2-C_{10} alkenyl. In some embodiments, R_5 is carboxyl. In some embodiments, R_5 is unsubstituted carbohydrate. In some embodiments, R_5 is substituted carbohydrate. In some embodiments, R_5 is unsubstituted ester. In some embodiments, R_5 is substituted ester. In some embodiments, R_5 is unsubstituted acyloxy. In some embodiments, R_5 is substituted acyloxy. In some embodiments, R_5 is nitro. In some embodiments, R_5 is halogen. In some embodiments, R_5 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is substituted C_6-C_{10}

aralkyl acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is unsubstituted alkoxy. In some embodiments, R_5 is substituted alkoxy. In some embodiments, R_5 is unsubstituted aryl. In some embodiments, R_5 is substituted aryl. In some embodiments, R_5 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is unsubstituted heteroaryl, In some embodiments, R_5 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is $-OPO_3WY$. In some embodiments, R_5 is $-OCH_2PO_4WY$. In some embodiments, R_5 is $-OCH_2PO_4Z$. In some embodiments, R_5 is $-OPO_3Z$.

[00665] In some embodiments, R_{10} is hydrogen. In some embodiments, R_{10} is hydroxyl. In some embodiments, R_{10} is carboxaldehyde. In some embodiments, R_{10} is unsubstituted amine. In some embodiments, R_{10} is substituted amine. In some embodiments, R_{10} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{10} is substituted C_1-C_{10} alkyl. In some embodiments, R_{10} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{10} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{10} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{10} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{10} is carboxyl. In some embodiments, R_{10} is unsubstituted carbohydrate. In some embodiments, R_{10} is substituted carbohydrate. In some embodiments, R_{10} is unsubstituted ester. In some embodiments, R_{10} is substituted ester. In some embodiments, R_{10} is unsubstituted acyloxy. In some embodiments, R_{10} is substituted acyloxy. In some embodiments, R_{10} is nitro. In some embodiments, R_{10} is halogen. In some embodiments, R_{10} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{10} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{10} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{10} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{10} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{10} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{10} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{10} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{10} is unsubstituted alkoxy. In some embodiments, R_{10} is substituted alkoxy. In some embodiments, R_{10} is unsubstituted aryl. In some embodiments, R_{10} is substituted aryl. In some embodiments, R_{10} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{10} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{10} is unsubstituted heteroaryl, In some embodiments, R_{10} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{10} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{10} is $-OPO_3WY$. In some embodiments, R_{10} is $-OCH_2PO_4WY$. In some embodiments, R_{10} is $-OCH_2PO_4Z$. In some embodiments, R_{10} is $-OPO_3Z$.

[00666] In some embodiments, R_{11} is hydrogen. In some embodiments, R_{11} is hydroxyl. In some embodiments, R_{11} is carboxaldehyde. In some embodiments, R_{11} is unsubstituted amine. In some embodiments, R_{11} is substituted amine. In some embodiments, R_{11} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{11} is substituted C_1-C_{10} alkyl. In some embodiments, R_{11} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{11} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{11} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{11} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{11} is carboxyl. In some embodiments, R_{11} is unsubstituted carbohydrate. In some embodiments, R_{11} is substituted carbohydrate. In some embodiments, R_{11} is unsubstituted ester. In some embodiments, R_{11} is substituted ester. In some embodiments, R_{11} is unsubstituted acyloxy. In some embodiments, R_{11} is substituted acyloxy. In some embodiments, R_{11} is nitro. In some embodiments, R_{11} is halogen. In some embodiments, R_{11} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{11} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{11} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{11} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{11} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{11} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{11} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{11} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{11} is unsubstituted alkoxy. In some

embodiments, R_{11} is substituted alkoxy. In some embodiments, R_{11} is unsubstituted aryl. In some embodiments, R_{11} is substituted aryl. In some embodiments, R_{11} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{11} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{11} is unsubstituted heteroaryl, In some embodiments, R_{11} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{11} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{11} is $-OPO_3WY$. In some embodiments, R_{11} is $-OCH_2PO_4WY$. In some embodiments, R_{11} is $-OCH_2PO_4Z$. In some embodiments, R_{11} is $-OPO_3Z$.

[00667] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate l. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00668] In some embodiments, R_{17} is hydrogen. In some embodiments, R_{17} is hydroxy. In some embodiments, R_{17} is carboxaldehyde. In some embodiments, R_{17} is unsubstituted amine. In some embodiments, R_{17} is substituted amine. In some embodiments, R_{17} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is carboxyl. In some embodiments, R_{17} is unsubstituted carbohydrate. In some embodiments, R_{17} is substituted carbohydrate. In some embodiments, R_{17} is unsubstituted ester. In some embodiments, R_{17} is substituted ester. In some embodiments, R_{17} is unsubstituted acyloxy. In some embodiments, R_{17} is substituted acyloxy. In some embodiments, R_{17} is nitro. In some embodiments, R_{17} is halogen. In some embodiments, R_{17} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is unsubstituted alkoxy. In some embodiments, R_{17} is substituted alkoxy. In some embodiments, R_{17} is unsubstituted aryl. In some embodiments, R_{17} is substituted aryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is unsubstituted heteroaryl. In some embodiments, R_{17} is substituted heteroaryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is $-OPO_3WY$. In some embodiments, R_{17} is $-OCH_2PO_4WY$. In some embodiments, R_{17} is $-OCH_2PO_4Z$. In some embodiments, R_{17} is $-OPO_3Z$.

[00669] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00670] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00671] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21}

is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00672] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

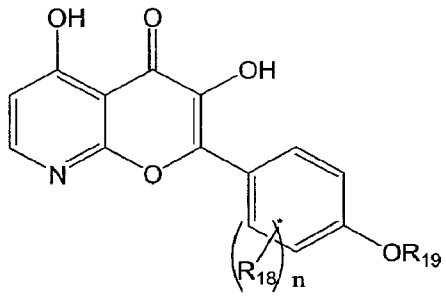
[00673] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00674] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

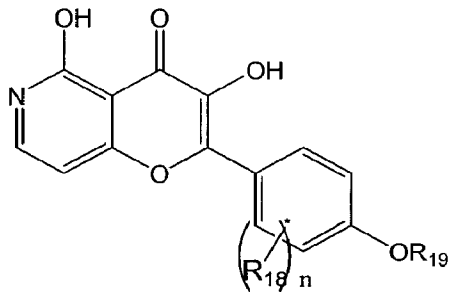
[00675] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00676] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00677] In some embodiments of the invention, the pyrone analog of Formula IV is of Formula XXIV or Formula XXV or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXIV



Formula XXV

[00678] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00679] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00680] n is an integer of 0, 1, 2, 3, or 4; and

[00681] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation.

[00682] In some embodiments of the invention, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of r R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00683] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

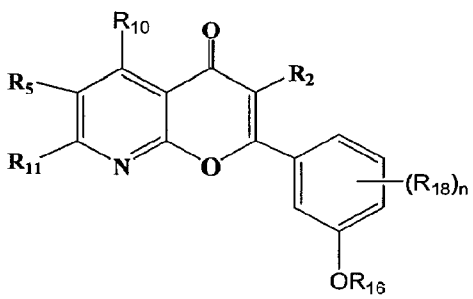
[00684] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00685] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

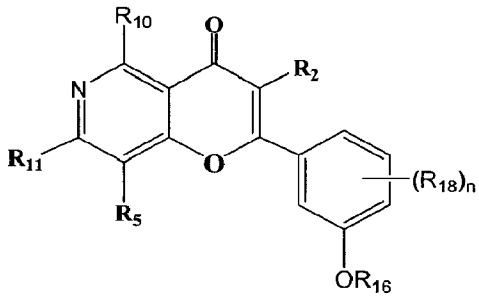
[00686] In various embodiments, W and Y are independently potassium, sodium, or lithium.

[00687] In various embodiments, Z is calcium, magnesium or iron.

[00688] In some embodiments of the invention, the pyrone analog of Formula IV is of Formula XXVI or Formula XXVII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXVI



Formula XXVII

[00689] wherein R_2, R_5, W, Y, and Z are as defined for Formula II and R_{10} and R_{11} are as defined for Formula IV;

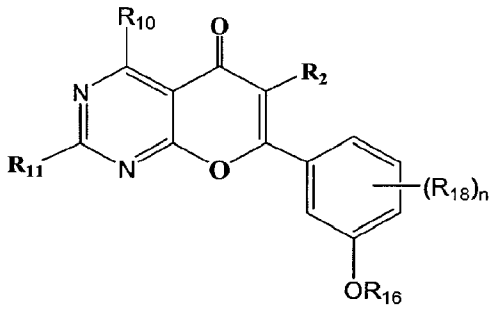
[00690] R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00691] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00692] n is an integer of 0, 1, 2, 3, or 4.

[00693] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00694] In some embodiments of the invention, the pyrone analog of Formula IV is of Formula XXVIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXVIII

[00695] wherein R_2, W, Y, and Z are as defined for Formula II and R_{10} and R_{11} are as defined for Formula IV;

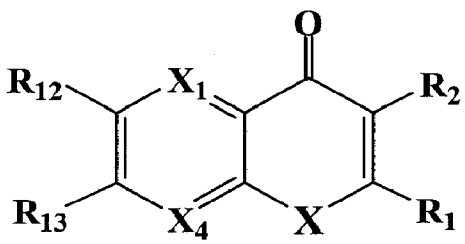
[00696] R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00697] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00698] n is an integer of 0, 1, 2, 3, or 4.

[00699] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00700] In some embodiments of the invention, the pyrone analog of Formula II is of Formula V or a pharmaceutically/veterinarily acceptable salt thereof:



Formula V

[00701] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

[00702] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

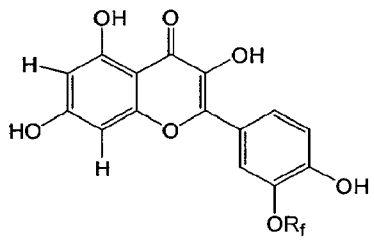
[00703] X_1 and X_4 are independently CR_5, O, S, or N;

[00704] each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00705] R_{12} and R_{13} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00706] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00707] wherein the compound of Formula V is not the compound of Formula A:



Formula A

[00708] wherein R_f is hydrogen.

[00709] In some embodiments, the compound of Formula V is not the compound of Formula A wherein R_f is PO_3K_2.

[00710] In some embodiments, X is O.

[00711] In other embodiments, X is S.

[00712] In yet other embodiments, X is NR'.

[00713] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

[00714] In some embodiments, X_1 is CR_5.

[00715] In other embodiments, X_1 is O.

[00716] In yet other embodiments, X_1 is S.

[00717] In further embodiments, X_1 is N.

[00718] In other embodiments, X_4 is CR_5.

[00719] In some embodiments, X_4 is O.

[00720] In yet other embodiments, X_4 is S.

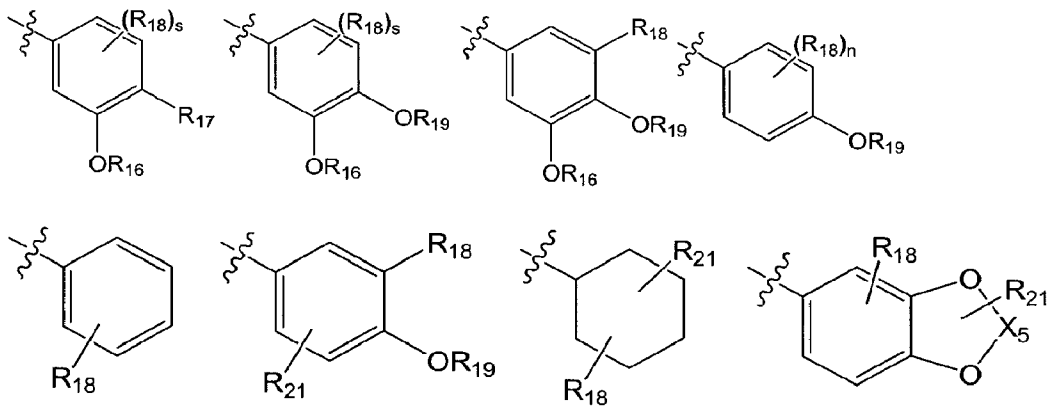
[00721] In some embodiments, X_4 is N.

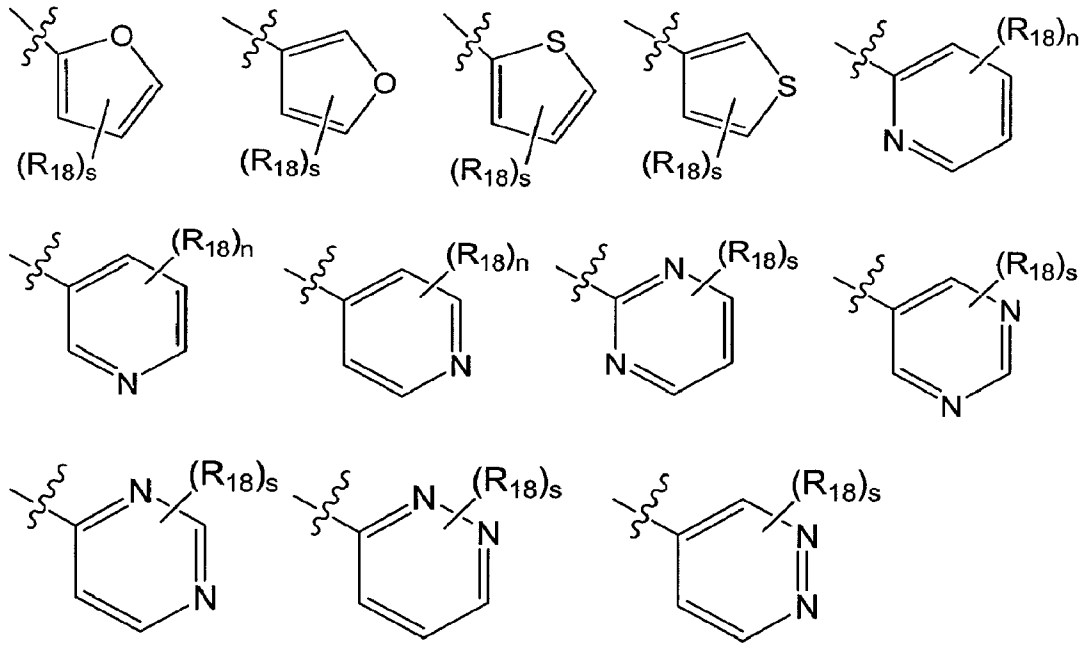
[00722] In some embodiments, at least one of X_1 or X_4 is N.

[00723] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00724] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00725] In various embodiments, R_1 is one of the following formulae:





[00726] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00727] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00728] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00729] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00730] s is an integer of 0, 1, 2, or 3; and

[00731] n is an integer of 0, 1, 2, 3, or 4.

[00732] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00733] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted

carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, $R_2$is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00734] In some embodiments, R_5 is hydrogen. In some embodiments, R_5 is hydroxyl. In some embodiments, R_5 is carboxaldehyde. In some embodiments, R_5 is unsubstituted amine. In some embodiments, R_5 is substituted amine. In some embodiments, R_5 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_5 is substituted C_1-C_{10} alkyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_5 is substituted C_2-C_{10} alkynyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, $R_5$is substituted C_2-C_{10} alkenyl. In some embodiments, R_5 is carboxyl. In some embodiments, R_5 is unsubstituted carbohydrate. In some embodiments, R_5 is substituted carbohydrate. In some embodiments, R_5 is unsubstituted ester. In some embodiments, R_5 is substituted ester. In some embodiments, R_5 is unsubstituted acyloxy. In some embodiments, R_5 is substituted acyloxy. In some embodiments, R_5 is nitro. In some embodiments, R_5 is halogen. In some embodiments, R_5 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is unsubstituted alkoxy. In some embodiments, R_5 is substituted alkoxy. In some embodiments, R_5 is unsubstituted aryl. In some embodiments, R_5 is substituted aryl. In some embodiments, R_5 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is unsubstituted heteroaryl, In some embodiments, R_5 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is $-OPO_3WY$. In some embodiments, R_5 is $-OCH_2PO_4WY$. In some embodiments, R_5 is $-OCH_2PO_4Z$. In some embodiments, R_5 is $-OPO_3Z$.

[00735] In some embodiments, R_{12} is hydrogen. In some embodiments, R_{12} is hydroxyl. In some embodiments, R_{12} is carboxaldehyde. In some embodiments, R_{12} is unsubstituted amine. In some embodiments, R_{12} is substituted amine. In some embodiments, R_{12} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{12} is substituted C_1-C_{10} alkyl. In some embodiments, R_{12} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{12} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{12} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{12} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{12} is carboxyl. In some embodiments, R_{12} is unsubstituted carbohydrate. In some embodiments, R_{12} is substituted carbohydrate. In some embodiments, R_{12} is unsubstituted ester. In some

embodiments, R_{12} is substituted ester. In some embodiments, R_{12} is unsubstituted acyloxy. In some embodiments, R_{12} is substituted acyloxy. In some embodiments, R_{12} is nitro. In some embodiments, R_{12} is halogen. In some embodiments, R_{12} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{12} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{12} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{12} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{12} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{12} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{12} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{12} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{12} is unsubstituted alkoxy. In some embodiments, R_{12} is substituted alkoxy. In some embodiments, R_{12} is unsubstituted aryl. In some embodiments, R_{12} is substituted aryl. In some embodiments, R_{12} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{12} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{12} is unsubstituted heteroaryl. In some embodiments, R_{12} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{12} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{12} is $-OPO_3WY$. In some embodiments, R_{12} is $-OCH_2PO_4WY$. In some embodiments, R_{12} is $-OCH_2PO_4Z$. In some embodiments, R_{12} is $-OPO_3Z$.

[00736] In some embodiments, R_{13} is hydrogen. In some embodiments, R_{13} is hydroxyl. In some embodiments, R_{13} is carboxaldehyde. In some embodiments, R_{13} is unsubstituted amine. In some embodiments, R_{13} is substituted amine. In some embodiments, R_{13} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{13} is substituted C_1-C_{10} alkyl. In some embodiments, R_{13} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{13} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{13} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{13} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{13} is carboxyl. In some embodiments, R_{13} is unsubstituted carbohydrate. In some embodiments, R_{13} is substituted carbohydrate. In some embodiments, R_{13} is unsubstituted ester. In some embodiments, R_{13} is substituted ester. In some embodiments, R_{13} is unsubstituted acyloxy. In some embodiments, R_{13} is substituted acyloxy. In some embodiments, R_{13} is nitro. In some embodiments, R_{13} is halogen. In some embodiments, R_{13} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{13} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{13} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{13} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{13} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{13} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{13} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{13} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{13} is unsubstituted alkoxy. In some embodiments, R_{13} is substituted alkoxy. In some embodiments, R_{13} is unsubstituted aryl. In some embodiments, R_{13} is substituted aryl. In some embodiments, R_{13} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{13} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{13} is unsubstituted heteroaryl, In some embodiments, R_{13} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{13} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{13} is $-OPO_3WY$. In some embodiments, R_{13} is $-OCH_2PO_4WY$. In some embodiments, R_{13} is $-OCH_2PO_4Z$. In some embodiments, R_{13} is $-OPO_3Z$.

[00737] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl

acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00738] In some embodiments, R_{17} is hydrogen. In some embodiments, R_{17} is hydroxy. In some embodiments, R_{17} is carboxaldehyde. In some embodiments, R_{17} is unsubstituted amine. In some embodiments, R_{17} is substituted amine. In some embodiments, R_{17} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{17} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{17} is carboxyl. In some embodiments, R_{17} is unsubstituted carbohydrate. In some embodiments, R_{17} is substituted carbohydrate. In some embodiments, R_{17} is unsubstituted ester. In some embodiments, R_{17} is substituted ester. In some embodiments, R_{17} is unsubstituted acyloxy. In some embodiments, R_{17} is substituted acyloxy. In some embodiments, R_{17} is nitro. In some embodiments, R_{17} is halogen. In some embodiments, R_{17} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{17} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{17} is unsubstituted alkoxy. In some embodiments, R_{17} is substituted alkoxy. In some embodiments, R_{17} is unsubstituted aryl. In some embodiments, R_{17} is substituted aryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{17} is unsubstituted heteroaryl. In some embodiments, R_{17} is substituted heteroaryl. In some embodiments, R_{17} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{17} is $-OPO_3WY$. In some embodiments, R_{17} is $-OCH_2PO_4WY$. In some embodiments, R_{17} is $-OCH_2PO_4Z$. In some embodiments, R_{17} is $-OPO_3Z$.

[00739] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is

substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00740] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00741] In some embodiments, R_{21} is hydrogen. In some embodiments, R_{21} is hydroxy. In some embodiments, R_{21} is carboxaldehyde. In some embodiments, R_{21} is unsubstituted amine. In some embodiments, R_{21} is substituted amine. In some embodiments, R_{21} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{21} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{21} is carboxyl. In some embodiments, R_{21} is unsubstituted carbohydrate. In some embodiments, R_{21} is substituted carbohydrate. In some embodiments, R_{21} is unsubstituted ester. In some embodiments, R_{21} is substituted ester. In some embodiments, R_{21} is unsubstituted acyloxy. In some embodiments, R_{21} is substituted acyloxy. In some embodiments, R_{21} is nitro. In some embodiments, R_{21} is halogen. In some embodiments, R_{21} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{21} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{21} is unsubstituted alkoxy. In some embodiments, R_{21} is substituted alkoxy. In some embodiments, R_{21} is unsubstituted aryl. In some embodiments, R_{21} is substituted aryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{21} is unsubstituted heteroaryl. In some embodiments, R_{21} is substituted heteroaryl. In some embodiments, R_{21} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{21} is $-OPO_3WY$. In some embodiments, R_{21} is $-OCH_2PO_4WY$. In some embodiments, R_{21} is $-OCH_2PO_4Z$. In some embodiments, R_{21} is $-OPO_3Z$.

[00742] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

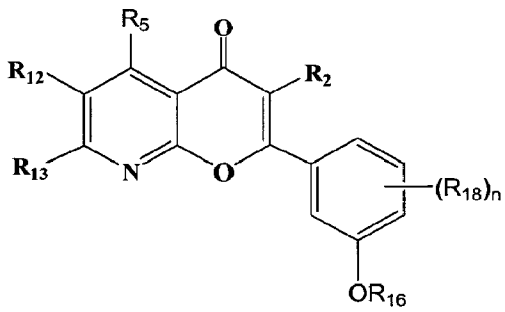
[00743] In some embodiments, n is an integer of 0. In some embodiments, n is an integer of 1. In some embodiments, n is an integer of 2. In some embodiments, n is an integer of 3. In some embodiments, n is an integer of 4.

[00744] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

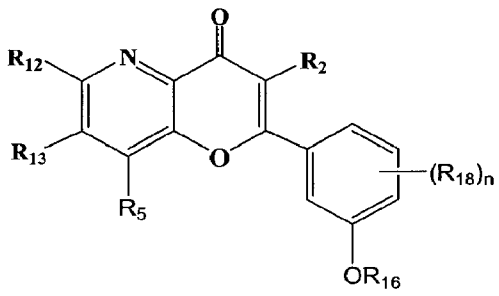
[00745] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00746] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00747] In some embodiments of the invention, the pyrone analog of Formula V is of Formula XXIX or Formula XXX or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXIX



Formula XXX

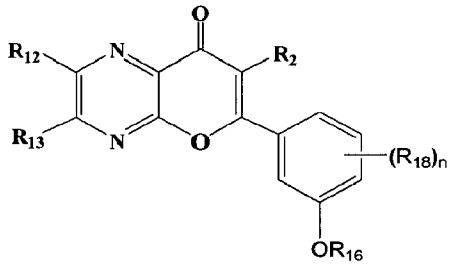
[00748] wherein R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00749] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00750] n is an integer of 0, 1, 2, 3, or 4.

[00751] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00752] In some embodiments of the invention, the pyrone analog of Formula V is of Formula XXXI or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXXI

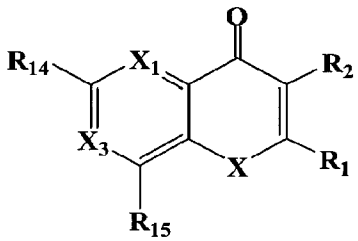
[00753] wherein R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00754] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00755] n is an integer of 0, 1, 2, 3, or 4.

[00756] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00757] In some embodiments of the invention, the pyrone analog of Formula II is of Formula VI or a pharmaceutically/veterinarily acceptable salt thereof:



Formula VI

[00758] wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

[00759] R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00760] X_1 and X_4 are independently CR_5, O, S, or N;

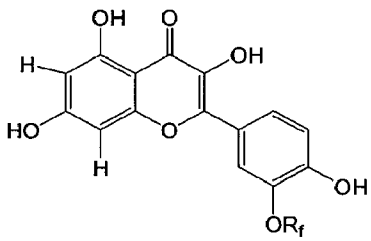
[00761] each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00762] R_{14} and R_{15} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl,

C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00763] W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

[00764] wherein the compound of Formula VI is not the compound of Formula A:



Formula A

[00765] wherein R_f is hydrogen.

[00766] In some embodiments, the compound of Formula VI is not the compound of Formula A wherein R_f is PO_3K_2.

[00767] In some embodiments, X is O.

[00768] In other embodiments, X is S.

[00769] In yet other embodiments, X is NR'.

[00770] In some embodiments, R' is hydrogen. In some embodiments, R' is unsubstituted C_1-C_{10} alkyl. In some embodiments, R' is substituted C_1-C_{10} alkyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R' is substituted C_2-C_{10} alkynyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R' is substituted C_2-C_{10} alkenyl. In some embodiments, R' is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R' is substituted C_6-C_{10} aromatic acyl. In some embodiments, R' is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R' is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R' is unsubstituted aryl. In some embodiments, R' is substituted aryl. In some embodiments, R' is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R' is substituted C_3-C_{10} heterocyclyl. In some embodiments, R' is unsubstituted heteroaryl. In some embodiments, R' is substituted heteroaryl. In some embodiments, R' is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R' is substituted C_3-C_{10}cycloalkyl.

[00771] In some embodiments, X_1 is CR_5.

[00772] In other embodiments, X_1 is O.

[00773] In yet other embodiments, X_1 is S.

[00774] In further embodiments, X_1 is N.

[00775] In other embodiments, X_3 is CR_5.

[00776] In some embodiments, X_3 is O.

[00777] In yet other embodiments, X_3 is S.

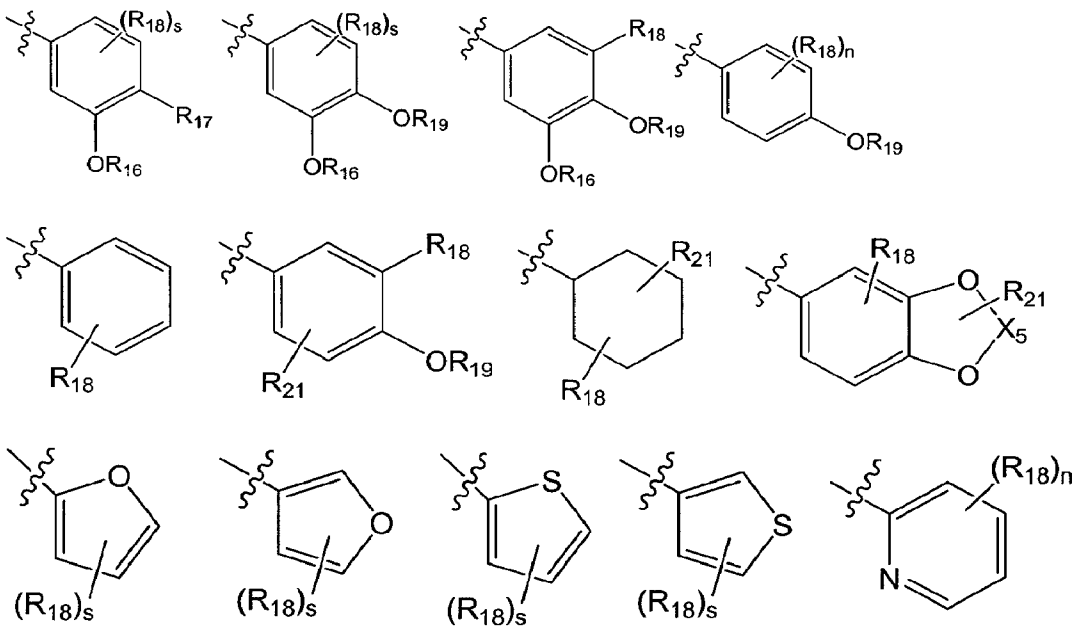
[00778] In some embodiments, X_3 is N.

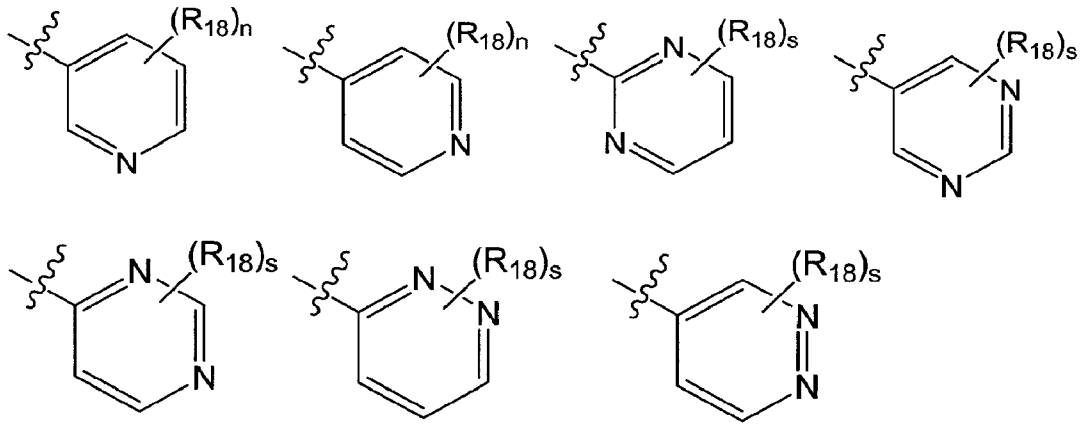
[00779] In some embodiments, at least one of X_1 or X_3 is N.

[00780] In some embodiments, R_1 is hydrogen. In some embodiments, R_1 is hydroxyl. In some embodiments, R_1 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_1 is substituted C_1-C_{10} alkyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_1 is substituted C_2-C_{10} alkynyl. In some embodiments, R_1 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_1 is substituted C_2-C_{10} alkenyl. In some embodiments, R_1 is carboxyl. In some embodiments, R_1 is unsubstituted carbohydrate. In some embodiments, R_1 is substituted carbohydrate. In some embodiments, R_1 is unsubstituted ester. In some embodiments, R_1 is substituted ester. In some embodiments, R_1 is unsubstituted acyloxy. In some embodiments, R_1 is substituted acyloxy. In some embodiments, R_1 is nitro. In some embodiments, R_1 is halogen. In some embodiments, R_1 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_1 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_1 is unsubstituted alkoxy. In some embodiments, R_1 is substituted alkoxy. In some embodiments, R_1 is unsubstituted amine. In some embodiments, R_1 is substituted amine. In some embodiments, R_1 is unsubstituted aryl. In some embodiments, R_1 is substituted aryl. In some embodiments, R_1 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_1 is unsubstituted heteroaryl. In some embodiments, R_1 is substituted heteroaryl. In some embodiments, R_1 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_1 is $-OPO_3WY$. In some embodiments, R_1 is $-OCH_2PO_4WY$. In some embodiments, R_1 is $-OCH_2PO_4Z$. In some embodiments, R_1 is $-OPO_3Z$.

[00781] In some embodiments, when R_1 is aryl, it is monocyclic. In some embodiments, when R_1 is aryl, it is bicyclic. In some embodiments, when R_1 is heteroaryl, it is monocyclic. In some embodiments, when R_1 is heteroaryl, it is bicyclic.

[00782] In various embodiments, R_1 is one of the following formulae:





[00783] wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00784] R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00785] each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

[00786] R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00787] s is an integer of 0, 1, 2, or 3; and

[00788] n is an integer of 0, 1, 2, 3, or 4.

[00789] In some embodiments of the invention, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{17} or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00790] In some embodiments, R_2 is hydrogen. In some embodiments, R_2 is hydroxyl. In some embodiments, R_2 is optionally substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_1-C_{10} alkyl. In some other embodiments, R_2 is substituted C_1-C_{10} alkyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_2 is substituted C_2-C_{10} alkynyl. In some embodiments, R_2 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_2 is substituted C_2-C_{10} alkenyl. In some embodiments, R_2 is carboxyl. In some embodiments, R_2 is unsubstituted carbohydrate. In some embodiments, R_2 is substituted carbohydrate. In some embodiments, R_2 is unsubstituted ester. In some embodiments, R_2 is substituted ester. In some embodiments, R_2 is unsubstituted acyloxy. In some embodiments, R_2 is substituted acyloxy. In some embodiments, R_2 is nitro. In some embodiments, R_2 is halogen. In some embodiments, R_2 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_2 is unsubstituted C_6-C_{10} aralkyl acyl. In some

embodiments, R_2 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, $R_2$is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_2 is unsubstituted alkoxy. In some embodiments, R_2 is substituted alkoxy. In some embodiments, R_2 is unsubstituted amine. In some embodiments, R_2 is substituted amine. In some embodiments, R_2 is unsubstituted aryl. In some embodiments, R_2 is substituted aryl. In some embodiments, R_2 is unsubstituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is substituted C_4-C_{10} heterocyclyl. In some embodiments, R_2 is unsubstituted heteroaryl. In some embodiments, R_2 is substituted heteroaryl. In some embodiments, R_2 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_2 is $-OPO_3WY$. In some embodiments, R_2 is $-OCH_2PO_4WY$. In some embodiments, R_2 is $-OCH_2PO_4Z$. In some embodiments, R_2 is $-OPO_3Z$.

[00791] In some embodiments, R_5 is hydrogen. In some embodiments, R_5 is hydroxyl. In some embodiments, R_5 is carboxaldehyde. In some embodiments, R_5 is unsubstituted amine. In some embodiments, R_5 is substituted amine. In some embodiments, R_5 is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_5 is substituted C_1-C_{10} alkyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_5 is substituted C_2-C_{10} alkynyl. In some embodiments, R_5 is unsubstituted C_2-C_{10} alkenyl. In some embodiments, $R_5$is substituted C_2-C_{10} alkenyl. In some embodiments, R_5 is carboxyl. In some embodiments, R_5 is unsubstituted carbohydrate. In some embodiments, R_5 is substituted carbohydrate. In some embodiments, R_5 is unsubstituted ester. In some embodiments, R_5 is substituted ester. In some embodiments, R_5 is unsubstituted acyloxy. In some embodiments, R_5 is substituted acyloxy. In some embodiments, R_5 is nitro. In some embodiments, R_5 is halogen. In some embodiments, R_5 is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_5 is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_5 is unsubstituted alkoxy. In some embodiments, R_5 is substituted alkoxy. In some embodiments, R_5 is unsubstituted aryl. In some embodiments, R_5 is substituted aryl. In some embodiments, R_5 is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_5 is unsubstituted heteroaryl, In some embodiments, R_5 is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_5 is $-OPO_3WY$. In some embodiments, R_5 is $-OCH_2PO_4WY$. In some embodiments, R_5 is $-OCH_2PO_4Z$. In some embodiments, R_5 is $-OPO_3Z$.

[00792] In some embodiments, R_{14} is hydrogen. In some embodiments, R_{14} is hydroxyl. In some embodiments, R_{14} is carboxaldehyde. In some embodiments, R_{14} is unsubstituted amine. In some embodiments, R_{14} is substituted amine. In some embodiments, R_{14} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{14} is substituted C_1-C_{10} alkyl. In some embodiments, R_{14} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{14} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{14} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{14} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{14} is carboxyl. In some embodiments, R_{14} is unsubstituted carbohydrate. In some embodiments, R_{14} is substituted carbohydrate. In some embodiments, R_{14} is unsubstituted ester. In some embodiments, R_{14} is substituted ester. In some embodiments, R_{14} is unsubstituted acyloxy. In some embodiments, R_{14} is substituted acyloxy. In some embodiments, R_{14} is nitro. In some embodiments, R_{14} is halogen. In some embodiments, R_{14} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{14} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{14} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{14} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{14} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{14} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{14} is unsubstituted C_6-C_{10} alkylaryl acyl. In some

embodiments, R_{14} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{14} is unsubstituted alkoxy. In some embodiments, R_{14} is substituted alkoxy. In some embodiments, R_{14} is unsubstituted aryl. In some embodiments, R_{14} is substituted aryl. In some embodiments, R_{14} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{14} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{14} is unsubstituted heteroaryl. In some embodiments, R_{14} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{14} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{14} is $-OPO_3WY$. In some embodiments, R_{14} is $-OCH_2PO_4WY$. In some embodiments, R_{14} is $-OCH_2PO_4Z$. In some embodiments, R_{14} is $-OPO_3Z$.

[00793] In some embodiments, R_{15} is hydrogen. In some embodiments, R_{15} is hydroxyl. In some embodiments, R_{15} is carboxaldehyde. In some embodiments, R_{15} is unsubstituted amine. In some embodiments, R_{15} is substituted amine. In some embodiments, R_{15} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{15} is substituted C_1-C_{10} alkyl. In some embodiments, R_{15} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{15} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{15} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{15} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{15} is carboxyl. In some embodiments, R_{15} is unsubstituted carbohydrate. In some embodiments, R_{15} is substituted carbohydrate. In some embodiments, R_{15} is unsubstituted ester. In some embodiments, R_{15} is substituted ester. In some embodiments, R_{15} is unsubstituted acyloxy. In some embodiments, R_{15} is substituted acyloxy. In some embodiments, R_{13} is nitro. In some embodiments, R_{13} is halogen. In some embodiments, R_{13} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{15} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{15} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{15} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{15} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{15} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{15} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{15} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{15} is unsubstituted alkoxy. In some embodiments, R_{15} is substituted alkoxy. In some embodiments, R_{15} is unsubstituted aryl. In some embodiments, R_{15} is substituted aryl. In some embodiments, R_{15} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{15} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{15} is unsubstituted heteroaryl, In some embodiments, R_{15} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{15} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{15} is $-OPO_3WY$. In some embodiments, R_{15} is $-OCH_2PO_4WY$. In some embodiments, R_{15} is $-OCH_2PO_4Z$. In some embodiments, R_{15} is $-OPO_3Z$.

[00794] In some embodiments, R_{16} is hydrogen. In some embodiments, R_{16} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{16} is substituted C_1-C_{10} alkyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{16} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{16} is unsubstituted carbohydrate. In some embodiments, R_{16} is substituted carbohydrate. In some embodiments, R_{16} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{16} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{16} is unsubstituted aryl. In some embodiments, R_{16} is substituted aryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{16} is unsubstituted heteroaryl. In some embodiments, R_{16} is substituted heteroaryl. In some embodiments, R_{16} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{16} is $-PO_3WY$. In some embodiments, R_{16} is $-CH_2PO_4WY$. In some embodiments, R_{16} is $-CH_2PO_4Z$. In some embodiments, R_{16} is $-PO_3Z$.

[00795] In some embodiments, R_{18} is hydrogen. In some embodiments, R_{18} is hydroxy. In some embodiments, R_{18} is carboxaldehyde. In some embodiments, R_{18} is unsubstituted amine. In some embodiments, R_{18} is substituted amine. In some embodiments, R_{18} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{18} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{18} is carboxyl. In some embodiments, R_{18} is unsubstituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is substituted carbohydrate. In some embodiments, R_{18} is unsubstituted ester. In some embodiments, R_{18} is substituted ester. In some embodiments, R_{18} is unsubstituted acyloxy. In some embodiments, R_{18} is substituted acyloxy. In some embodiments, R_{18} is nitro. In some embodiments, R_{18} is halogen. In some embodiments, R_{18} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{18} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{18} is unsubstituted alkoxy. In some embodiments, R_{18} is substituted alkoxy. In some embodiments, R_{18} is unsubstituted aryl. In some embodiments, R_{18} is substituted aryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{18} is unsubstituted heteroaryl. In some embodiments, R_{18} is substituted heteroaryl. In some embodiments, R_{18} is unsubstituted C_3-C_{10}cycloalkyl. . In some embodiments, R_{18} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{18} is $-OPO_3WY$. In some embodiments, R_{18} is $-OCH_2PO_4WY$. In some embodiments, R_{18} is $-OCH_2PO_4Z$. In some embodiments, R_{18} is $-OPO_3Z$.

[00796] In some embodiments, R_{19} is hydrogen. In some embodiments, R_{19} is unsubstituted C_1-C_{10} alkyl. In some embodiments, R_{19} is substituted C_1-C_{10} alkyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkynyl. In some embodiments, R_{19} is unsubstituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is substituted C_2-C_{10} alkenyl. In some embodiments, R_{19} is unsubstituted carbohydrate. In some embodiments, R_{19} is substituted carbohydrate. In some embodiments, R_{19} is unsubstituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is substituted C_1-C_{10} aliphatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aromatic acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} aralkyl acyl. In some embodiments, R_{19} is unsubstituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is substituted C_6-C_{10} alkylaryl acyl. In some embodiments, R_{19} is unsubstituted aryl. In some embodiments, R_{19} is substituted aryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is substituted C_3-C_{10} heterocyclyl. In some embodiments, R_{19} is unsubstituted heteroaryl. In some embodiments, R_{19} is substituted heteroaryl. In some embodiments, R_{19} is unsubstituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is substituted C_3-C_{10}cycloalkyl. In some embodiments, R_{19} is $-PO_3WY$. In some embodiments, R_{19} is $-CH_2PO_4WY$. In some embodiments, R_{19} is $-CH_2PO_4Z$. In some embodiments, R_{19} is $-PO_3Z$.

[00797] In some embodiments, s is an integer of 0. In some embodiments, s is an integer of 1. In some embodiments, s is an integer of 2. In some embodiments, s is an integer of 3.

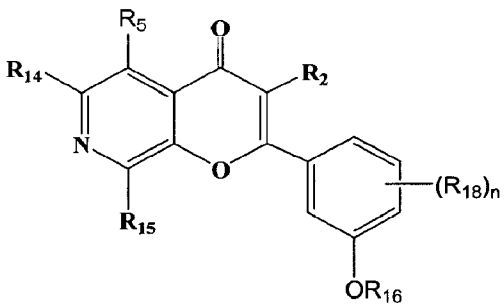
[00798] In various embodiments, W is hydrogen. In various embodiments, W is unsubstituted methyl. In various embodiments, W is substituted methyl. In various embodiments, W is unsubstituted ethyl. In various embodiments, W is substituted ethyl. In various embodiments, W is unsubstituted alkyl. In various embodiments, W is substituted alkyl. In various embodiments, W is unsubstituted carbohydrate. In various embodiments, W is substituted

carbohydrate. In various embodiments, W is potassium. In various embodiments, W is sodium. In various embodiments, W is lithium.

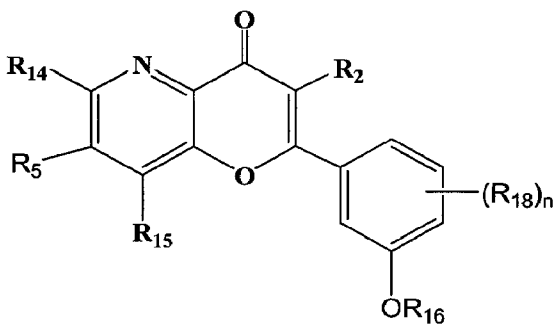
[00799] In various embodiments, Y is hydrogen. In various embodiments, Y is unsubstituted methyl. In various embodiments, Y is substituted methyl. In various embodiments, Y is unsubstituted ethyl. In various embodiments, Y is substituted ethyl. In various embodiments, Y is unsubstituted alkyl. In various embodiments, Y is substituted alkyl. In various embodiments, Y is unsubstituted carbohydrate. In various embodiments, Y is substituted carbohydrate. In various embodiments, Y is potassium. In various embodiments, Y is sodium. In various embodiments, Y is lithium.

[00800] In various embodiments, Z is calcium. In various embodiments, Z is magnesium. In various embodiments, Z is iron.

[00801] In some embodiments of the invention, the pyrone analog of Formula VI is of Formula XXXII or Formula XXXIII or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXXIII



Formula XXXIV

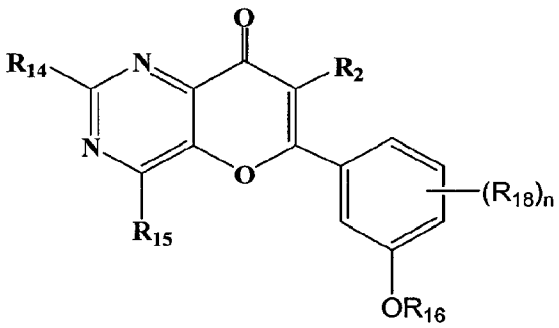
[00802] wherein R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00803] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00804] n is an integer of 0, 1, 2, 3, or 4.

[00805] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00806] In some embodiments of the invention, the pyrone analog of Formula VI is of Formula XXXIV or a pharmaceutically/veterinarily acceptable salt thereof:



Formula XXXIV

[00807] wherein R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

[00808] wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

[00809] n is an integer of 0, 1, 2, 3, or 4.

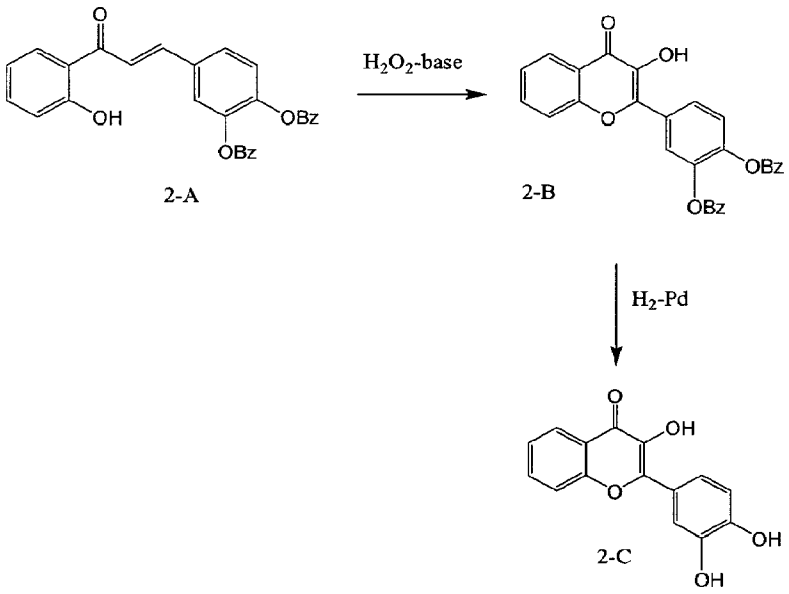
[00810] In some embodiments of the invention, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$. In some embodiments, R_{16} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$ and at least one of R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

[00811] Each instance of R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8. R_9, R_{10}, R_{11}, R_{12}, R_{13}, R_{14}, R_{15}, R_{16}, R_{17}, R_{18}, R_{19}, R_{20}, R_{21}, W, Y and Z disclosed may be used in any combination in any of the Formulae I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX, XX, XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII, XXIX, XXX, XXXI, XXXII, XXXIII, and XXXIV.

III. METHODS OF SYNTHESIS OF THE COMPOUNDS OF THE INVENTION

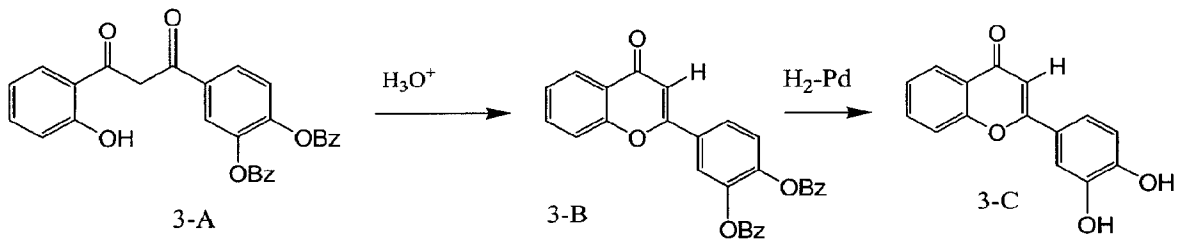
[00812] The compounds of the invention may be synthesized via several approaches, and the particular synthesis route is chosen depending on the substituent pattern of the desired compound. The routes are illustrated with selected members of the class of compounds of the invention, but can be used for other compounds described herein. Note that Scheme 1 is found at paragraph 222.

Scheme 2. Approach to 3-hydroxy flavones via oxidative cyclization.



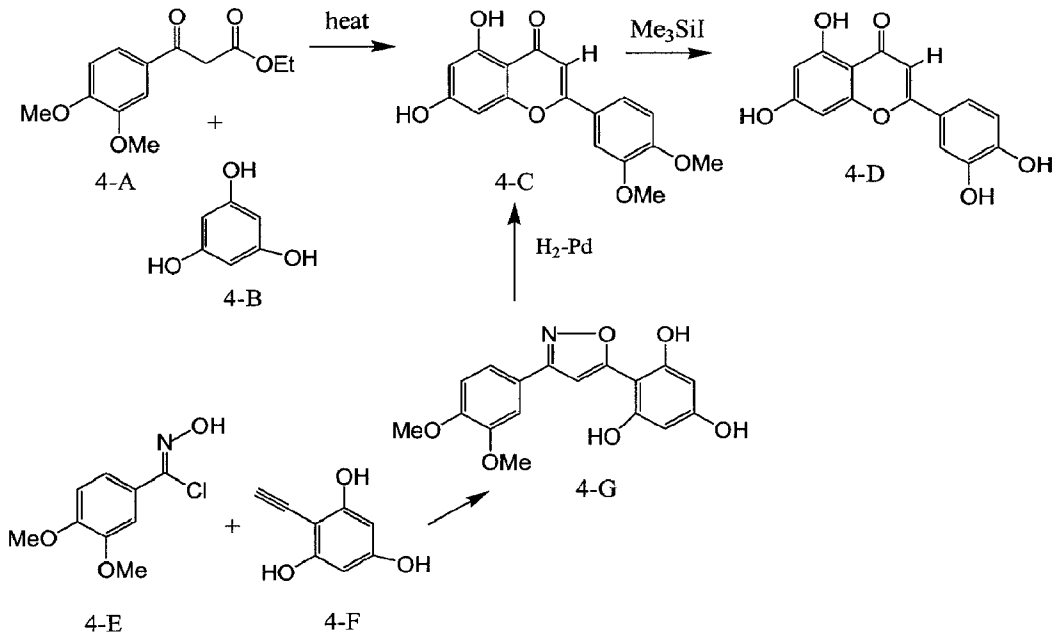
[00813] In this synthetic route, a benzyl protected ortho- hydroxyphenyl – styrylketone 2-A is cyclized to yield a 3-hydroxy flavone using hydrogen peroxide and base. Deprotection via treatment with hydrogen and palladium catalysts yields a 3'-, 4'- dihydroxyphenyl 3-hydroxy flavone 2-C. (See Chemical Research in Toxicology, 17(6), 795-804 (2004).)

Scheme 3. A synthetic approach to flavone analogs is illustrated.



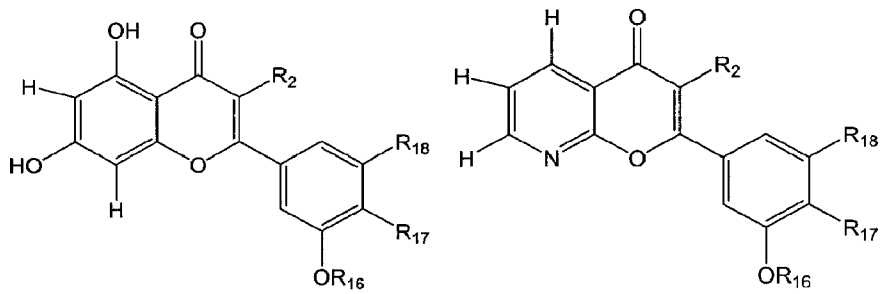
[00814] Another approach to compounds of the invention is via acid catalyzed cyclization of an 1-ortho-hydroxyphenyl- 3-aryl-1, 3, propanedione 3-A to yield a flavone analog 3-C, as is illustrated in Scheme 3. Benzyl protection of the dihydroxy substituents on the 3-aryl moiety is shown, but methyl ether protection may also be used. After cyclization is accomplished, the protecting groups are removed from compound 3-B. In the case of benzyl protection, treatment with hydrogen in the presence of a palladium is used. If methyl ether protection is used, treatment of the cyclized protected species analogous to compound 3-B with trimethylsilyl iodide will produce the final product 3-C. (See Chemical Research in Toxicology, 17(6), 795-804 (2004).)

Scheme 4. Alternative Routes to Flavone analogs.



[00815] Alternative cyclizations to yield flavone analogs may also be used and is illustrated in Scheme 4. Beta-ketoester 4-A is cyclized with 1, 3, 5, trihydroxybenzene using heat to yield the protected flavone 4-C. Deprotection with trimethylsilyl iodide yields a flavone 4-D. The same intermediate 4-C is obtained by reacting the acetylenic trihydroxybenzene 4-F with compound 4-E to yield the tricyclic intermediate 4-G. Reduction of 4-G with hydrogen over palladium yields 4-C, which can be converted to the flavone 4-D as before. (See Faming Zhuanli Shenquig Gongkai Shuomingshu 1666987 (2005), and Acta Chemica Scandinavica 49(7), 524-9 (1995).)

IV. EXEMPLARY COMPOUNDS OF THE INVENTION



Formula B **Formula C**

[00816] Key: Substituents described in Table 1 of exemplary compounds are abbreviated as shown herein.

E= -O-glucoronide	G= -glucoronide
J= $-PO_3T$	K=$-OPO_3T$
V= $-CH_2OPO_3T$	L= $-OCH_2OPO_3T$

[00817] Table A: Exemplary formulas of T as described in the Exemplary compounds of Formula B or Formula C as disclosed in Table 1.

Subclass #	T	Subclass #	T
S-1	H, H	S-2	H, K
S-3	K, K	S-4	H, Li
S-5	Li, Li	S-6	H, Na
S-7	Na, Na	S-8	H, Me
S-9	Me, Me	S-10	H, ethyl
S-11	ethyl, ethyl	S-12	H, glucose
S-13	Glucose, glucose	S-14	Ca
S-15	Mg	S-16	Fe(II)
S-17	Zn		

[00818] Table 1. Exemplary compounds of Formula B or Formula C. Each subclass in Table 1, utilizes each subclass of "T" as described in Table A.

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
2	x					x					x						x								
3	x					x					x							x							
4	x					x					x								x						
5	x					x					x									x					
6	x					x					x										x				
7	x					x					x											x			
8	x					x					x												x		
9	x					x					x													x	
10	x					x					x														x
11	x					x						x					x								
12	x					x						x						x							
13	x					x						x							x						
14	x					x						x								x					
15	x					x						x									x				
16	x					x						x										x			
17	x					x						x											x		
18	x					x						x												x	
19	x					x						x													x
20	x					x							x				x								
21	x					x							x					x							
22	x					x							x						x						
23	x					x							x							x					
24	x					x							x								x				
25	x					x							x									x			
26	x					x							x												
27	x					x							x										x		

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
28	x					x							x											x	
29	x					x							x												x
30	x					x								x			x								
31	x					x								x				x							
32	x					x								x					x						
33	x					x								x						x					
34	x					x								x							x				
35	x					x								x								x			
36	x					x								x									x		
37	x					x								x										x	
38	x					x								x											x
39	x					x									x		x								
40	x					x									x			x							
41	x					x									x				x						
42	x					x									x					x					
43	x					x									x						x				
44	x					x									x							x			
45	x					x									x								x		
46	x					x									x									x	
47	x					x									x										x
48	x					x										x	x								
49	x					x										x		x							
50	x					x										x			x						
51	x					x										x				x					
52	x					x										x					x				
53	x					x										x						x			
54	x					x										x							x		
55	x					x										x								x	
56	x					x										x									x
57	x						x				x						x								
58	x						x				x							x							
59	x						x				x								x						
60	x						x				x									x					
61	x						x				x										x				
62	x						x				x											x			
63	x						x				x												x		
64	x						x				x													x	
65	x						x				x														x
66	x						x					x					x								
67	x						x					x						x							
68	x						x					x							x						
69	x						x					x								x					
70	x						x					x									x				
71	x						x					x										x			
72	x						x					x											x		
73	x						x					x												x	
74	x						x					x													x
75	x						x						x				x								

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
76	x						x						x					x							
77	x						x						x						x						
78	x						x						x							x					
79	x						x						x								x				
80	x						x						x									x			
81	x						x						x												
82	x						x						x										x		
83	x						x						x											x	
84	x						x						x												x
85	x						x							x			x								
86	x						x							x				x							
87	x						x							x					x						
88	x						x							x						x					
89	x						x							x							x				
90	x						x							x								x			
91	x						x							x									x		
92	x						x							x										x	
93	x						x							x											x
94	x						x								x		x								
95	x						x								x			x							
96	x						x								x				x						
97	x						x								x					x					
98	x						x								x						x				
99	x						x								x							x			
100	x						x								x								x		
101	x						x								x									x	
102	x						x								x										x
103	x						x									x	x								
104	x						x									x		x							
105	x						x									x			x						
106	x						x									x				x					
107	x						x									x					x				
108	x						x									x						x			
109	x						x									x							x		
110	x						x									x								x	
111	x						x									x									x
112	x							x			x						x								
113	x							x			x							x							
114	x							x			x								x						
115	x							x			x									x					
116	x							x			x										x				
117	x							x			x											x			
118	x							x			x												x		
119	x							x			x													x	
120	x							x			x														x
121	x							x				x					x								
122	x							x				x						x							
123	x							x				x							x						

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
124	x							x				x								x					
125	x							x				x									x				
126	x							x				x										x			
127	x							x				x											x		
128	x							x				x												x	
129	x							x				x													x
130	x							x					x				x								
131	x							x					x					x							
132	x							x					x						x						
133	x							x					x							x					
134	x							x					x								x				
135	x							x					x									x			
136	x							x					x												
137	x							x					x										x		
138	x							x					x											x	
139	x							x					x												x
140	x							x						x			x								
141	x							x						x				x							
142	x							x						x					x						
143	x							x						x						x					
144	x							x						x							x				
145	x							x						x								x			
146	x							x						x									x		
147	x							x						x										x	
148	x							x						x											x
149	x							x							x		x								
150	x							x							x			x							
151	x							x							x				x						
152	x							x							x					x					
153	x							x							x						x				
154	x							x							x							x			
155	x							x							x								x		
156	x							x							x									x	
157	x							x							x										x
158	x							x								x	x								
159	x							x								x		x							
160	x							x								x			x						
161	x							x								x				x					
162	x							x								x					x				
163	x							x								x						x			
164	x							x								x							x		
165	x							x								x								x	
166	x							x								x									x
167	x								x		x						x								
168	x								x		x							x							
169	x								x		x								x						
170	x								x		x									x					
171	x								x		x										x				

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
172	x								x		x											x			
173	x								x		x												x		
174	x								x		x													x	
175	x								x		x														x
176	x								x			x					x								
177	x								x			x						x							
178	x								x			x							x						
179	x								x			x								x					
180	x								x			x									x				
181	x								x			x										x			
182	x								x			x											x		
183	x								x			x												x	
184	x								x			x													x
185	x								x				x				x								
186	x								x				x					x							
187	x								x				x						x						
188	x								x				x							x					
189	x								x				x								x				
190	x								x				x									x			
191	x								x				x												
192	x								x				x										x		
193	x								x				x											x	
194	x								x				x												x
195	x								x					x			x								
196	x								x					x				x							
197	x								x					x					x						
198	x								x					x						x					
199	x								x					x							x				
200	x								x					x								x			
201	x								x					x									x		
202	x								x					x										x	
203	x								x					x											x
204	x								x						x		x								
205	x								x						x			x							
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207	x								x						x					x					
208	x								x						x						x				
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211	x								x						x									x	
212	x								x						x										x
213	x								x							x	x								
214	x								x							x		x							
215	x								x							x			x						
216	x								x							x				x					
217	x								x							x					x				
218	x								x							x						x			
219	x								x							x							x		

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
220	x								x							x								x	
221	x								x							x									x
222	x									x	x						x								
223	x									x	x							x							
224	x									x	x								x						
225	x									x	x									x					
226	x									x	x										x				
227	x									x	x											x			
228	x									x	x												x		
229	x									x	x													x	
230	x									x	x														x
231	x									x		x					x								
232	x									x		x						x							
233	x									x		x							x						
234	x									x		x								x					
235	x									x		x									x				
236	x									x		x										x			
237	x									x		x											x		
238	x									x		x												x	
239	x									x		x													x
240	x									x			x				x								
241	x									x			x					x							
242	x									x			x						x						
243	x									x			x							x					
244	x									x			x								x				
245	x									x			x									x			
246	x									x			x												
247	x									x			x										x		
248	x									x			x											x	
249	x									x			x												x
250	x									x				x			x								
251	x									x				x				x							
252	x									x				x					x						
253	x									x				x						x					
254	x									x				x							x				
255	x									x				x								x			
256	x									x				x									x		
257	x									x				x										x	
258	x									x				x											x
259	x									x					x		x								
260	x									x					x			x							
261	x									x					x				x						
262	x									x					x					x					
263	x									x					x						x				
264	x									x					x							x			
265	x									x					x								x		
266	x									x					x									x	
267	x									x					x										x

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
268	x									x						x	x								
269	x									x						x		x							
270	x									x						x			x						
271	x									x						x				x					
272	x									x						x					x				
273	x									x						x						x			
274	x									x						x							x		
275	x									x						x								x	
276	x									x						x									x
277		x				x					x						x								
278		x				x					x							x							
279		x				x					x								x						
280		x				x					x									x					
281		x				x					x										x				
282		x				x					x											x			
283		x				x					x												x		
284		x				x					x													x	
285		x				x					x														x
286		x				x						x					x								
287		x				x						x						x							
288		x				x						x							x						
289		x				x						x								x					
290		x				x						x									x				
291		x				x						x										x			
292		x				x						x											x		
293		x				x						x												x	
294		x				x						x													x
295		x				x							x				x								
296		x				x							x					x							
297		x				x							x						x						
298		x				x							x							x					
299		x				x							x								x				
300		x				x							x									x			
301		x				x							x												
302		x				x							x										x		
303		x				x							x											x	
304		x				x							x												x
305		x				x								x			x								
306		x				x								x				x							
307		x				x								x					x						
308		x				x								x						x					
309		x				x								x							x				
310		x				x								x								x			
311		x				x								x									x		
312		x				x								x										x	
313		x				x								x											x
314		x				x									x		x								
315		x				x									x			x							

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
316		x				x									x				x						
317		x				x									x					x					
318		x				x									x						x				
319		x				x									x							x			
320		x				x									x								x		
321		x				x									x									x	
322		x				x									x										x
323		x				x										x	x								
324		x				x										x		x							
325		x				x										x			x						
326		x				x										x				x					
327		x				x										x					x				
328		x				x										x						x			
329		x				x										x							x		
330		x				x										x								x	
331		x				x										x									x
332		x					x				x						x								
333		x					x				x							x							
334		x					x				x								x						
335		x					x				x									x					
336		x					x				x										x				
337		x					x				x											x			
338		x					x				x												x		
339		x					x				x													x	
340		x					x				x														x
341		x					x					x					x								
342		x					x					x						x							
343		x					x					x							x						
344		x					x					x								x					
345		x					x					x									x				
346		x					x					x										x			
347		x					x					x											x		
348		x					x					x												x	
349		x					x					x													x
350		x					x						x				x								
351		x					x						x					x							
352		x					x						x						x						
353		x					x						x							x					
354		x					x						x								x				
355		x					x						x									x			
356		x					x						x												
357		x					x						x										x		
358		x					x						x											x	
359		x					x						x												x
360		x					x							x			x								
361		x					x							x				x							
362		x					x							x					x						
363		x					x							x						x					

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
364		x					x							x							x				
365		x					x							x								x			
366		x					x							x									x		
367		x					x							x										x	
368		x					x							x											x
369		x					x								x		x								
370		x					x								x			x							
371		x					x								x				x						
372		x					x								x					x					
373		x					x								x						x				
374		x					x								x							x			
375		x					x								x								x		
376		x					x								x									x	
377		x					x								x										x
378		x					x									x	x								
379		x					x									x		x							
380		x					x									x			x						
381		x					x									x				x					
382		x					x									x					x				
383		x					x									x						x			
384		x					x									x							x		
385		x					x									x								x	
386		x					x									x									x
387		x						x			x						x								
388		x						x			x							x							
389		x						x			x								x						
390		x						x			x									x					
391		x						x			x										x				
392		x						x			x											x			
393		x						x			x												x		
394		x						x			x													x	
395		x						x			x														x
396		x						x				x					x								
397		x						x				x						x							
398		x						x				x							x						
399		x						x				x								x					
400		x						x				x									x				
401		x						x				x										x			
402		x						x				x											x		
403		x						x				x												x	
404		x						x				x													x
405		x						x					x				x								
406		x						x					x					x							
407		x						x					x						x						
408		x						x					x							x					
409		x						x					x								x				
410		x						x					x									x			
411		x						x					x												

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
412		x						x					x										x		
413		x						x					x											x	
414		x						x					x												x
415		x						x						x			x								
416		x						x						x				x							
417		x						x						x					x						
418		x						x						x						x					
419		x						x						x							x				
420		x						x						x								x			
421		x						x						x									x		
422		x						x						x										x	
423		x						x						x											x
424		x						x							x		x								
425		x						x							x			x							
426		x						x							x				x						
427		x						x							x					x					
428		x						x							x						x				
429		x						x							x							x			
430		x						x							x								x		
431		x						x							x									x	
432		x						x							x										x
433		x						x								x	x								
434		x						x								x		x							
435		x						x								x			x						
436		x						x								x				x					
437		x						x								x					x				
438		x						x								x						x			
439		x						x								x							x		
440		x						x								x								x	
441		x						x								x									x
442		x							x		x						x								
443		x							x		x							x							
444		x							x		x								x						
445		x							x		x									x					
446		x							x		x										x				
447		x							x		x											x			
448		x							x		x												x		
449		x							x		x													x	
450		x							x		x														x
451		x							x			x					x								
452		x							x			x						x							
453		x							x			x							x						
454		x							x			x								x					
455		x							x			x									x				
456		x							x			x										x			
457		x							x			x											x		
458		x							x			x												x	
459		x							x			x													x

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
460		x							x				x				x								
461		x							x				x					x							
462		x							x				x						x						
463		x							x				x							x					
464		x							x				x								x				
465		x							x				x									x			
466		x							x				x												
467		x							x				x										x		
468		x							x				x											x	
469		x							x				x												x
470		x							x					x			x								
471		x							x					x				x							
472		x							x					x					x						
473		x							x					x						x					
474		x							x					x							x				
475		x							x					x								x			
476		x							x					x									x		
477		x							x					x										x	
478		x							x					x											x
479		x							x						x		x								
480		x							x						x			x							
481		x							x						x				x						
482		x							x						x					x					
483		x							x						x						x				
484		x							x						x							x			
485		x							x						x								x		
486		x							x						x									x	
487		x							x						x										x
488		x							x							x	x								
489		x							x							x		x							
490		x							x							x			x						
491		x							x							x				x					
492		x							x							x					x				
493		x							x							x						x			
494		x							x							x							x		
495		x							x							x								x	
496		x							x							x									x
497		x								x	x						x								
498		x								x	x							x							
499		x								x	x								x						
500		x								x	x									x					
501		x								x	x										x				
502		x								x	x											x			
503		x								x	x												x		
504		x								x	x													x	
505		x								x	x														x
506		x								x		x					x								
507		x								x		x						x							

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
508		x								x		x							x						
509		x								x		x								x					
510		x								x		x									x				
511		x								x		x										x			
512		x								x		x											x		
513		x								x		x												x	
514		x								x		x													x
515		x								x			x				x								
516		x								x			x					x							
517		x								x			x						x						
518		x								x			x							x					
519		x								x			x								x				
520		x								x			x									x			
521		x								x			x												
522		x								x			x										x		
523		x								x			x											x	
524		x								x			x												x
525		x								x				x			x								
526		x								x				x				x							
527		x								x				x					x						
528		x								x				x						x					
529		x								x				x							x				
530		x								x				x								x			
531		x								x				x									x		
532		x								x				x										x	
533		x								x				x											x
534		x								x					x		x								
535		x								x					x			x							
536		x								x					x				x						
537		x								x					x					x					
538		x								x					x						x				
539		x								x					x							x			
540		x								x					x								x		
541		x								x					x									x	
542		x								x					x										x
543		x								x						x	x								
544		x								x						x		x							
545		x								x						x			x						
546		x								x						x				x					
547		x								x						x					x				
548		x								x						x						x			
549		x								x						x							x		
550		x								x						x								x	
551		x								x						x									x
552			x			x					x						x								
553			x			x					x							x							
554			x			x					x								x						
555			x			x					x									x					

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
556			x			x					x										x				
557			x			x					x											x			
558			x			x					x												x		
559			x			x					x													x	
560			x			x					x														x
561			x			x						x					x								
562			x			x						x						x							
563			x			x						x							x						
564			x			x						x								x					
565			x			x						x									x				
566			x			x						x										x			
567			x			x						x											x		
568			x			x						x												x	
569			x			x						x													x
570			x			x							x				x								
571			x			x							x					x							
572			x			x							x						x						
573			x			x							x							x					
574			x			x							x								x				
575			x			x							x									x			
576			x			x							x												
577			x			x							x										x		
578			x			x							x											x	
579			x			x							x												x
580			x			x								x			x								
581			x			x								x				x							
582			x			x								x					x						
583			x			x								x						x					
584			x			x								x							x				
585			x			x								x								x			
586			x			x								x									x		
587			x			x								x										x	
588			x			x								x											x
589			x			x									x		x								
590			x			x									x			x							
591			x			x									x				x						
592			x			x									x					x					
593			x			x									x						x				
594			x			x									x							x			
595			x			x									x								x		
596			x			x									x									x	
597			x			x									x										x
598			x			x										x	x								
599			x			x										x		x							
600			x			x										x			x						
601			x			x										x				x					
602			x			x										x					x				
603			x			x										x						x			

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
604			x			x										x							x		
605			x			x										x								x	
606			x			x										x									x
607			x				x				x						x								
608			x				x				x							x							
609			x				x				x								x						
610			x				x				x									x					
611			x				x				x										x				
612			x				x				x											x			
613			x				x				x												x		
614			x				x				x													x	
615			x				x				x														x
616			x				x					x					x								
617			x				x					x						x							
618			x				x					x							x						
619			x				x					x								x					
620			x				x					x									x				
621			x				x					x										x			
622			x				x					x											x		
623			x				x					x												x	
624			x				x					x													x
625			x				x						x				x								
626			x				x						x					x							
627			x				x						x						x						
628			x				x						x							x					
629			x				x						x								x				
630			x				x						x									x			
631			x				x						x												
632			x				x						x										x		
633			x				x						x											x	
634			x				x						x												x
635			x				x							x			x								
636			x				x							x				x							
637			x				x							x					x						
638			x				x							x						x					
639			x				x							x							x				
640			x				x							x								x			
641			x				x							x									x		
642			x				x							x										x	
643			x				x							x											x
644			x				x								x		x								
645			x				x								x			x							
646			x				x								x				x						
647			x				x								x					x					
648			x				x								x						x				
649			x				x								x							x			
650			x				x								x								x		
651			x				x								x									x	

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
652			x				x								x										x
653			x				x									x	x								
654			x				x									x		x							
655			x				x									x			x						
656			x				x									x				x					
657			x				x									x					x				
658			x				x									x						x			
659			x				x									x							x		
660			x				x									x								x	
661			x				x									x									x
662			x					x			x						x								
663			x					x			x							x							
664			x					x			x								x						
665			x					x			x									x					
666			x					x			x										x				
667			x					x			x											x			
668			x					x			x												x		
669			x					x			x													x	
670			x					x			x														x
671			x					x				x					x								
672			x					x				x						x							
673			x					x				x							x						
674			x					x				x								x					
675			x					x				x									x				
676			x					x				x										x			
677			x					x				x											x		
678			x					x				x												x	
679			x					x				x													x
680			x					x					x				x								
681			x					x					x					x							
682			x					x					x						x						
683			x					x					x							x					
684			x					x					x								x				
685			x					x					x									x			
686			x					x					x												
687			x					x					x										x		
688			x					x					x											x	
689			x					x					x												x
690			x					x						x			x								
691			x					x						x				x							
692			x					x						x					x						
693			x					x						x						x					
694			x					x						x							x				
695			x					x						x								x			
696			x					x						x									x		
697			x					x						x										x	
698			x					x						x											x
699			x					x							x		x								

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
700			x					x							x			x							
701			x					x							x				x						
702			x					x							x					x					
703			x					x							x						x				
704			x					x							x							x			
705			x					x							x								x		
706			x					x							x									x	
707			x					x							x										x
708			x					x								x	x								
709			x					x								x		x							
710			x					x								x			x						
711			x					x								x				x					
712			x					x								x					x				
713			x					x								x						x			
714			x					x								x							x		
715			x					x								x								x	
716			x					x								x									x
717			x						x		x						x								
718			x						x		x							x							
719			x						x		x								x						
720			x						x		x									x					
721			x						x		x										x				
722			x						x		x											x			
723			x						x		x												x		
724			x						x		x													x	
725			x						x		x														x
726			x						x			x					x								
727			x						x			x						x							
728			x						x			x							x						
729			x						x			x								x					
730			x						x			x									x				
731			x						x			x										x			
732			x						x			x											x		
733			x						x			x												x	
734			x						x			x													x
735			x						x				x				x								
736			x						x				x					x							
737			x						x				x						x						
738			x						x				x							x					
739			x						x				x								x				
740			x						x				x									x			
741			x						x				x												
742			x						x				x										x		
743			x						x				x											x	
744			x						x				x												x
745			x						x					x			x								
746			x						x					x				x							
747			x						x					x					x						

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
748			x						x					x						x					
749			x						x					x							x				
750			x						x					x								x			
751			x						x					x									x		
752			x						x					x										x	
753			x						x					x											x
754			x						x						x		x								
755			x						x						x			x							
756			x						x						x				x						
757			x						x						x					x					
758			x						x						x						x				
759			x						x						x							x			
760			x						x						x								x		
761			x						x						x									x	
762			x						x						x										x
763			x						x							x	x								
764			x						x							x		x							
765			x						x							x			x						
766			x						x							x				x					
767			x						x							x					x				
768			x						x							x						x			
769			x						x							x							x		
770			x						x							x								x	
771			x						x							x									x
772			x							x	x						x								
773			x							x	x							x							
774			x							x	x								x						
775			x							x	x									x					
776			x							x	x										x				
777			x							x	x											x			
778			x							x	x												x		
779			x							x	x													x	
780			x							x	x														x
781			x							x		x					x								
782			x							x		x						x							
783			x							x		x							x						
784			x							x		x								x					
785			x							x		x									x				
786			x							x		x										x			
787			x							x		x											x		
788			x							x		x												x	
789			x							x		x													x
790			x							x			x				x								
791			x							x			x					x							
792			x							x			x						x						
793			x							x			x							x					
794			x							x			x								x				
795			x							x			x									x			

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
796			x							x			x												
797			x							x			x										x		
798			x							x			x											x	
799			x							x			x												x
800			x							x				x			x								
801			x							x				x				x							
802			x							x				x					x						
803			x							x				x						x					
804			x							x				x							x				
805			x							x				x								x			
806			x							x				x									x		
807			x							x				x										x	
808			x							x				x											x
809			x							x					x		x								
810			x							x					x			x							
811			x							x					x				x						
812			x							x					x					x					
813			x							x					x						x				
814			x							x					x							x			
815			x							x					x								x		
816			x							x					x									x	
817			x							x					x										x
818			x							x						x	x								
819			x							x						x		x							
820			x							x						x			x						
821			x							x						x				x					
822			x							x						x					x				
823			x							x						x						x			
824			x							x						x							x		
825			x							x						x								x	
826			x							x						x									x
827				x		x					x						x								
828				x		x					x							x							
829				x		x					x								x						
830				x		x					x									x					
831				x		x					x										x				
832				x		x					x											x			
833				x		x					x												x		
834				x		x					x													x	
835				x		x					x														x
836				x		x						x					x								
837				x		x						x						x							
838				x		x						x							x						
839				x		x						x								x					
840				x		x						x									x				
841				x		x						x										x			
842				x		x						x											x		
843				x		x						x												x	

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
844				x		x						x													x
845				x		x							x				x								
846				x		x							x					x							
847				x		x							x						x						
848				x		x							x							x					
849				x		x							x								x				
850				x		x							x									x			
851				x		x							x												
852				x		x							x										x		
853				x		x							x											x	
854				x		x							x												x
855				x		x								x			x								
856				x		x								x				x							
857				x		x								x					x						
858				x		x								x						x					
859				x		x								x							x				
860				x		x								x								x			
861				x		x								x									x		
862				x		x								x										x	
863				x		x								x											x
864				x		x									x		x								
865				x		x									x			x							
866				x		x									x				x						
867				x		x									x					x					
868				x		x									x						x				
869				x		x									x							x			
870				x		x									x								x		
871				x		x									x									x	
872				x		x									x										x
873				x		x										x	x								
874				x		x										x		x							
875				x		x										x			x						
876				x		x										x				x					
877				x		x										x					x				
878				x		x										x						x			
879				x		x										x							x		
880				x		x										x								x	
881				x		x										x									x
882				x			x				x						x								
883				x			x				x							x							
884				x			x				x								x						
885				x			x				x									x					
886				x			x				x										x				
887				x			x				x											x			
888				x			x				x												x		
889				x			x				x													x	
890				x			x				x														x
891				x			x					x					x								

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
892				x			x					x						x							
893				x			x					x							x						
894				x			x					x								x					
895				x			x					x									x				
896				x			x					x										x			
897				x			x					x											x		
898				x			x					x												x	
899				x			x					x													x
900				x			x						x				x								
901				x			x						x					x							
902				x			x						x						x						
903				x			x						x							x					
904				x			x						x								x				
905				x			x						x									x			
906				x			x						x												
907				x			x						x										x		
908				x			x						x											x	
909				x			x						x												x
910				x			x							x			x								
911				x			x							x				x							
912				x			x							x					x						
913				x			x							x						x					
914				x			x							x							x				
915				x			x							x								x			
916				x			x							x									x		
917				x			x							x										x	
918				x			x							x											x
919				x			x								x		x								
920				x			x								x			x							
921				x			x								x				x						
922				x			x								x					x					
923				x			x								x						x				
924				x			x								x							x			
925				x			x								x								x		
926				x			x								x									x	
927				x			x								x										x
928				x			x									x	x								
929				x			x									x		x							
930				x			x									x			x						
931				x			x									x				x					
932				x			x									x					x				
933				x			x									x						x			
934				x			x									x							x		
935				x			x									x								x	
936				x			x									x									x
937				x				x			x						x								
938				x				x			x							x							
939				x				x			x								x						

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
940				x				x			x									x					
941				x				x			x										x				
942				x				x			x											x			
943				x				x			x												x		
944				x				x			x													x	
945				x				x			x														x
946				x				x				x					x								
947				x				x				x						x							
948				x				x				x							x						
949				x				x				x								x					
950				x				x				x									x				
951				x				x				x										x			
952				x				x				x											x		
953				x				x				x												x	
954				x				x				x													x
955				x				x					x				x								
956				x				x					x					x							
957				x				x					x						x						
958				x				x					x							x					
959				x				x					x								x				
960				x				x					x									x			
961				x				x					x												
962				x				x					x										x		
963				x				x					x											x	
964				x				x					x												x
965				x				x						x			x								
966				x				x						x				x							
967				x				x						x					x						
968				x				x						x						x					
969				x				x						x							x				
970				x				x						x								x			
971				x				x						x									x		
972				x				x						x										x	
973				x				x						x											x
974				x				x							x		x								
975				x				x							x			x							
976				x				x							x				x						
977				x				x							x					x					
978				x				x							x						x				
979				x				x							x							x			
980				x				x							x								x		
981				x				x							x									x	
982				x				x							x										x
983				x				x								x	x								
984				x				x								x		x							
985				x				x								x			x						
986				x				x								x				x					
987				x				x								x					x				

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
988				x				x								x						x			
989				x				x								x							x		
990				x				x								x								x	
991				x				x								x									x
992				x					x		x						x								
993				x					x		x							x							
994				x					x		x								x						
995				x					x		x									x					
996				x					x		x										x				
997				x					x		x											x			
998				x					x		x												x		
999				x					x		x													x	
1000				x					x		x														x
1001				x					x			x					x								
1002				x					x			x						x							
1003				x					x			x							x						
1004				x					x			x								x					
1005				x					x			x									x				
1006				x					x			x										x			
1007				x					x			x											x		
1008				x					x			x												x	
1009				x					x			x													x
1010				x					x				x				x								
1011				x					x				x					x							
1012				x					x				x						x						
1013				x					x				x							x					
1014				x					x				x								x				
1015				x					x				x									x			
1016				x					x				x												
1017				x					x				x										x		
1018				x					x				x											x	
1019				x					x				x												x
1020				x					x					x			x								
1021				x					x					x				x							
1022				x					x					x					x						
1023				x					x					x						x					
1024				x					x					x							x				
1025				x					x					x								x			
1026				x					x					x									x		
1027				x					x					x										x	
1028				x					x					x											x
1029				x					x						x		x								
1030				x					x						x			x							
1031				x					x						x				x						
1032				x					x						x					x					
1033				x					x						x						x				
1034				x					x						x							x			
1035				x					x						x								x		

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1036				x					x						x									x	
1037				x					x						x										x
1038				x					x							x	x								
1039				x					x							x		x							
1040				x					x							x			x						
1041				x					x							x				x					
1042				x					x							x					x				
1043				x					x							x						x			
1044				x					x							x							x		
1045				x					x							x								x	
1046				x					x							x									x
1047				x						x	x						x								
1048				x						x	x							x							
1049				x						x	x								x						
1050				x						x	x									x					
1051				x						x	x										x				
1052				x						x	x											x			
1053				x						x	x												x		
1054				x						x	x													x	
1055				x						x	x														x
1056				x						x		x					x								
1057				x						x		x						x							
1058				x						x		x							x						
1059				x						x		x								x					
1060				x						x		x									x				
1061				x						x		x										x			
1062				x						x		x											x		
1063				x						x		x												x	
1064				x						x		x													x
1065				x						x			x				x								
1066				x						x			x					x							
1067				x						x			x						x						
1068				x						x			x							x					
1069				x						x			x								x				
1070				x						x			x									x			
1071				x						x			x												
1072				x						x			x										x		
1073				x						x			x											x	
1074				x						x			x												x
1075				x						x				x			x								
1076				x						x				x				x							
1077				x						x				x					x						
1078				x						x				x						x					
1079				x						x				x							x				
1080				x						x				x								x			
1081				x						x				x									x		
1082				x						x				x										x	
1083				x						x				x											x

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1084				x						x					x		x								
1085				x						x					x			x							
1086				x						x					x				x						
1087				x						x					x					x					
1088				x						x					x						x				
1089				x						x					x							x			
1090				x						x					x								x		
1091				x						x					x									x	
1092				x						x					x										x
1093				x						x						x	x								
1094				x						x						x		x							
1095				x						x						x			x						
1096				x						x						x				x					
1097				x						x						x					x				
1098				x						x						x						x			
1099				x						x						x							x		
1100				x						x						x								x	
1101				x						x						x									x
1102					x	x					x						x								
1103					x	x					x							x							
1104					x	x					x								x						
1105					x	x					x									x					
1106					x	x					x										x				
1107					x	x					x											x			
1108					x	x					x												x		
1109					x	x					x													x	
1110					x	x					x														x
1111					x	x						x					x								
1112					x	x						x						x							
1113					x	x						x							x						
1114					x	x						x								x					
1115					x	x						x									x				
1116					x	x						x										x			
1117					x	x						x											x		
1118					x	x						x												x	
1119					x	x						x													x
1120					x	x							x				x								
1121					x	x							x					x							
1122					x	x							x						x						
1123					x	x							x							x					
1124					x	x							x								x				
1125					x	x							x									x			
1126					x	x							x												
1127					x	x							x										x		
1128					x	x							x											x	
1129					x	x							x												x
1130					x	x								x			x								
1131					x	x								x				x							

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1132					x	x								x					x						
1133					x	x								x						x					
1134					x	x								x							x				
1135					x	x								x								x			
1136					x	x								x									x		
1137					x	x								x										x	
1138					x	x								x											x
1139					x	x									x		x								
1140					x	x									x			x							
1141					x	x									x				x						
1142					x	x									x					x					
1143					x	x									x						x				
1144					x	x									x							x			
1145					x	x									x								x		
1146					x	x									x									x	
1147					x	x									x										x
1148					x	x										x	x								
1149					x	x										x		x							
1150					x	x										x			x						
1151					x	x										x				x					
1152					x	x										x					x				
1153					x	x										x						x			
1154					x	x										x							x		
1155					x	x										x								x	
1156					x	x										x									x
1157					x		x				x						x								
1158					x		x				x							x							
1159					x		x				x								x						
1160					x		x				x									x					
1161					x		x				x										x				
1162					x		x				x											x			
1163					x		x				x												x		
1164					x		x				x													x	
1165					x		x				x														x
1166					x		x					x					x								
1167					x		x					x						x							
1168					x		x					x							x						
1169					x		x					x								x					
1170					x		x					x									x				
1171					x		x					x										x			
1172					x		x					x											x		
1173					x		x					x												x	
1174					x		x					x													x
1175					x		x						x				x								
1176					x		x						x					x							
1177					x		x						x						x						
1178					x		x						x							x					
1179					x		x						x								x				

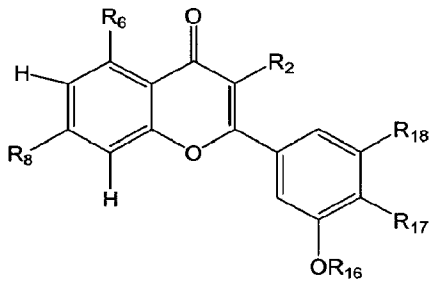
Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1180					x		x						x									x			
1181					x		x						x												
1182					x		x						x										x		
1183					x		x						x											x	
1184					x		x						x												x
1185					x		x							x			x								
1186					x		x							x				x							
1187					x		x							x					x						
1188					x		x							x						x					
1189					x		x							x							x				
1190					x		x							x								x			
1191					x		x							x									x		
1192					x		x							x										x	
1193					x		x							x											x
1194					x		x								x		x								
1195					x		x								x			x							
1196					x		x								x				x						
1197					x		x								x					x					
1198					x		x								x						x				
1199					x		x								x							x			
1200					x		x								x								x		
1201					x		x								x									x	
1202					x		x								x										x
1203					x		x									x	x								
1204					x		x									x		x							
1205					x		x									x			x						
1206					x		x									x				x					
1207					x		x									x					x				
1208					x		x									x						x			
1209					x		x									x							x		
1210					x		x									x								x	
1211					x		x									x									x
1212					x			x			x						x								
1213					x			x			x							x							
1214					x			x			x								x						
1215					x			x			x									x					
1216					x			x			x										x				
1217					x			x			x											x			
1218					x			x			x												x		
1219					x			x			x													x	
1220					x			x			x														x
1221					x			x				x					x								
1222					x			x				x						x							
1223					x			x				x							x						
1224					x			x				x								x					
1225					x			x				x									x				
1226					x			x				x										x			
1227					x			x				x											x		

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1228					x			x				x												x	
1229					x			x				x													x
1230					x			x					x				x								
1231					x			x					x					x							
1232					x			x					x						x						
1233					x			x					x							x					
1234					x			x					x								x				
1235					x			x					x									x			
1236					x			x					x												
1237					x			x					x										x		
1238					x			x					x											x	
1239					x			x					x												x
1240					x			x						x			x								
1241					x			x						x				x							
1242					x			x						x					x						
1243					x			x						x						x					
1244					x			x						x							x				
1245					x			x						x								x			
1246					x			x						x									x		
1247					x			x						x										x	
1248					x			x						x											x
1249					x			x							x		x								
1250					x			x							x			x							
1251					x			x							x				x						
1252					x			x							x					x					
1253					x			x							x						x				
1254					x			x							x							x			
1255					x			x							x								x		
1256					x			x							x									x	
1257					x			x							x										x
1258					x			x								x	x								
1259					x			x								x		x							
1260					x			x								x			x						
1261					x			x								x				x					
1262					x			x								x					x				
1263					x			x								x						x			
1264					x			x								x							x		
1265					x			x								x								x	
1266					x			x								x									x
1267					x				x		x						x								
1268					x				x		x							x							
1269					x				x		x								x						
1270					x				x		x									x					
1271					x				x		x										x				
1272					x				x		x											x			
1273					x				x		x												x		
1274					x				x		x													x	
1275					x				x		x														x

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1276					x				x			x					x								
1277					x				x			x						x							
1278					x				x			x							x						
1279					x				x			x								x					
1280					x				x			x									x				
1281					x				x			x										x			
1282					x				x			x											x		
1283					x				x			x												x	
1284					x				x			x													x
1285					x				x				x				x								
1286					x				x				x					x							
1287					x				x				x						x						
1288					x				x				x							x					
1289					x				x				x								x				
1290					x				x				x									x			
1291					x				x				x												
1292					x				x				x										x		
1293					x				x				x											x	
1294					x				x				x												x
1295					x				x					x			x								
1296					x				x					x				x							
1297					x				x					x					x						
1298					x				x					x						x					
1299					x				x					x							x				
1300					x				x					x								x			
1301					x				x					x									x		
1302					x				x					x										x	
1303					x				x					x											x
1304					x				x						x		x								
1305					x				x						x			x							
1306					x				x						x				x						
1307					x				x						x					x					
1308					x				x						x						x				
1309					x				x						x							x			
1310					x				x						x								x		
1311					x				x						x									x	
1312					x				x						x										x
1313					x				x							x	x								
1314					x				x							x		x							
1315					x				x							x			x						
1316					x				x							x				x					
1317					x				x							x					x				
1318					x				x							x						x			
1319					x				x							x							x		
1320					x				x							x								x	
1321					x				x							x									x
1322					x					x	x						x								
1323					x					x	x							x							

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1324					x					x	x								x						
1325					x					x	x									x					
1326					x					x	x										x				
1327					x					x	x											x			
1328					x					x	x												x		
1329					x					x	x													x	
1330					x					x	x														x
1331					x					x		x					x								
1332					x					x		x						x							
1333					x					x		x							x						
1334					x					x		x								x					
1335					x					x		x									x				
1336					x					x		x										x			
1337					x					x		x											x		
1338					x					x		x												x	
1339					x					x		x													x
1340					x					x			x				x								
1341					x					x			x					x							
1342					x					x			x						x						
1343					x					x			x							x					
1344					x					x			x								x				
1345					x					x			x									x			
1346					x					x			x												
1347					x					x			x										x		
1348					x					x			x											x	
1349					x					x			x												x
1350					x					x				x			x								
1351					x					x				x				x							
1352					x					x				x					x						
1353					x					x				x						x					
1354					x					x				x							x				
1355					x					x				x								x			
1356					x					x				x									x		
1357					x					x				x										x	
1358					x					x				x											x
1359					x					x					x		x								
1360					x					x					x			x							
1361					x					x					x				x						
1362					x					x					x					x					
1363					x					x					x						x				
1364					x					x					x							x			
1365					x					x					x								x		
1366					x					x					x									x	
1367					x					x					x										x
1368					x					x						x	x								
1369					x					x						x		x							
1370					x					x						x			x						
1371					x					x						x				x					

Sub-class #	R_2					R_{16}					R_{17}						R_{18}								
1	H	OH	E	K	L	H	Me	G	J	V	H	E	K	L	OMe	Me	H	E	K	L	Me	OH	NH_2	CN	F
1372					x					x						x					x				
1373					x					x						x						x			
1374					x					x						x							x		
1375					x					x						x								x	
1376					x					x						x									x



Formula D

[00819] Key: Substituents described in Table 2 of exemplary compounds of Formula D are abbreviated as shown herein.

E= -Oglucoronide	G= -glucoronide
J= $-PO_3T$	K=$-OPO_3T$
V= $-CH_2OPO_3T$	L= $-OCH_2OPO_3T$

[00820] Table A: Exemplary formulas of T as described in the Exemplary compounds of Formula D as disclosed in Table 2.

Subclass #	T	Subclass #	T
S-1	H, H	S-2	H, K
S-3	K, K	S-4	H, Li
S-5	Li, Li	S-6	H, Na
S-7	Na, Na	S-8	H, Me
S-9	Me, Me	S-10	H, ethyl
S-11	ethyl, ethyl	S-12	H, glucose
S-13	Glucose, glucose	S-14	Ca
S-15	Mg	S-16	Fe(II)
S-17	Zn		

[00821] Table 2. Exemplary compounds of Formula D. Each subclass in Table 2, utilizes each subclass of "T" as described in Table A.

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
2	x					x		x						x					x			x	
3	x					x		x						x					x				x
4	x					x		x						x						x		x	
5	x					x		x						x						x			x
6	x					x		x						x							x	x	
7	x					x		x						x							x		x
8	x					x		x							x				x			x	
9	x					x		x							x				x				x
10	x					x		x							x					x		x	
11	x					x		x							x					x			x
12	x					x		x							x						x	x	
13	x					x		x							x						x		x
14	x					x		x								x			x			x	
15	x					x		x								x			x				x
16	x					x		x								x				x		x	
17	x					x		x								x				x			x
18	x					x		x								x					x	x	
19	x					x		x								x					x		x
20	x					x		x									x		x			x	
21	x					x		x									x		x				x
22	x					x		x									x			x		x	
23	x					x		x									x			x			x
24	x					x		x									x				x	x	
25	x					x		x									x				x		x
26	x					x		x										x	x			x	
27	x					x		x										x	x				x
28	x					x		x										x		x		x	
29	x					x		x										x		x			x
30	x					x		x										x			x	x	
31	x					x		x										x			x		x
32	x					x			x					x					x			x	
33	x					x			x					x					x				x
34	x					x			x					x						x		x	
35	x					x			x					x						x			x
36	x					x			x					x							x	x	
37	x					x			x					x							x		x
38	x					x			x						x				x			x	
39	x					x			x						x				x				x
40	x					x			x						x					x		x	
41	x					x			x						x					x			x
42	x					x			x						x						x	x	
43	x					x			x						x						x		x
44	x					x			x							x			x			x	
45	x					x			x							x			x				x
46	x					x			x							x				x		x	
47	x					x			x							x				x			x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
48	x					x			x							x					x	x	
49	x					x			x							x					x		x
50	x					x			x								x		x			x	
51	x					x			x								x		x				x
52	x					x			x								x			x		x	
53	x					x			x								x			x			x
54	x					x			x								x				x	x	
55	x					x			x								x				x		x
56	x					x			x									x	x			x	
57	x					x			x									x	x				x
58	x					x			x									x		x		x	
59	x					x			x									x		x			x
60	x					x			x									x			x	x	
61	x					x			x									x			x		x
62	x					x				x				x					x			x	
63	x					x				x				x					x				x
64	x					x				x				x						x		x	
65	x					x				x				x						x			x
66	x					x				x				x							x	x	
67	x					x				x				x							x		x
68	x					x				x					x				x			x	
69	x					x				x					x				x				x
70	x					x				x					x					x		x	
71	x					x				x					x					x			x
72	x					x				x					x						x	x	
73	x					x				x					x						x		x
74	x					x				x						x			x			x	
75	x					x				x						x			x				x
76	x					x				x						x				x		x	
77	x					x				x						x				x			x
78	x					x				x						x					x	x	
79	x					x				x						x					x		x
80	x					x				x							x		x			x	
81	x					x				x							x		x				x
82	x					x				x							x			x		x	
83	x					x				x							x			x			x
84	x					x				x							x				x	x	
85	x					x				x							x				x		x
86	x					x				x								x	x			x	
87	x					x				x								x	x				x
88	x					x				x								x		x		x	
89	x					x				x								x		x			x
90	x					x				x								x			x	x	
91	x					x				x								x			x		x
92	x					x					x			x					x			x	
93	x					x					x			x					x				x
94	x					x					x			x						x		x	
95	x					x					x			x						x			x
96	x					x					x			x							x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
97	x					x					x			x							x		x
98	x					x					x				x				x			x	
99	x					x					x				x				x				x
100	x					x					x				x					x		x	
101	x					x					x				x					x			x
102	x					x					x				x						x	x	
103	x					x					x				x						x		x
104	x					x					x					x			x			x	
105	x					x					x					x			x				x
106	x					x					x					x				x		x	
107	x					x					x					x				x			x
108	x					x					x					x					x	x	
109	x					x					x					x					x		x
110	x					x					x						x		x			x	
111	x					x					x						x		x				x
112	x					x					x						x			x		x	
113	x					x					x						x			x			x
114	x					x					x						x				x	x	
115	x					x					x						x				x		x
116	x					x					x							x	x			x	
117	x					x					x							x	x				x
118	x					x					x							x		x		x	
119	x					x					x							x		x			x
120	x					x					x							x			x	x	
121	x					x					x							x			x		x
122	x					x						x		x					x			x	
123	x					x						x		x					x				x
124	x					x						x		x						x		x	
125	x					x						x		x						x			x
126	x					x						x		x							x	x	
127	x					x						x		x							x		x
128	x					x						x			x				x			x	
129	x					x						x			x				x				x
130	x					x						x			x					x		x	
131	x					x						x			x					x			x
132	x					x						x			x						x	x	
133	x					x						x			x						x		x
134	x					x						x				x			x			x	
135	x					x						x				x			x				x
136	x					x						x				x				x		x	
137	x					x						x				x				x			x
138	x					x						x				x					x	x	
139	x					x						x				x					x		x
140	x					x						x					x		x			x	
141	x					x						x					x		x				x
142	x					x						x					x			x		x	
143	x					x						x					x			x			x
144	x					x						x					x				x	x	
145	x					x						x					x				x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
146	x					x						x						x	x			x	
147	x					x						x						x	x				x
148	x					x						x						x		x		x	
149	x					x						x						x		x			x
150	x					x						x						x			x	x	
151	x					x						x						x			x		x
152	x					x							x	x					x			x	
153	x					x							x	x					x				x
154	x					x							x	x						x		x	
155	x					x							x	x						x			x
156	x					x							x	x							x	x	
157	x					x							x	x							x		x
158	x					x							x		x				x			x	
159	x					x							x		x				x				x
160	x					x							x		x					x		x	
161	x					x							x		x					x			x
162	x					x							x		x						x	x	
163	x					x							x		x						x		x
164	x					x							x			x			x			x	
165	x					x							x			x			x				x
166	x					x							x			x				x		x	
167	x					x							x			x				x			x
168	x					x							x			x					x	x	
169	x					x							x			x					x		x
170	x					x							x				x		x			x	
171	x					x							x				x		x				x
172	x					x							x				x			x		x	
173	x					x							x				x			x			x
174	x					x							x				x				x	x	
175	x					x							x				x				x		x
176	x					x							x					x	x			x	
177	x					x							x					x	x				x
178	x					x							x					x		x		x	
179	x					x							x					x		x			x
180	x					x							x					x			x	x	
181	x					x							x					x			x		x
182	x						x	x						x					x			x	
183	x						x	x						x					x				x
184	x						x	x						x						x		x	
185	x						x	x						x						x			x
186	x						x	x						x							x	x	
187	x						x	x						x							x		x
188	x						x	x							x				x			x	
189	x						x	x							x				x				x
190	x						x	x							x					x		x	
191	x						x	x							x					x			x
192	x						x	x							x						x	x	
193	x						x	x							x						x		x
194	x						x	x								x			x			x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
195	x						x	x								x			x				x
196	x						x	x								x				x		x	
197	x						x	x								x				x			x
198	x						x	x								x					x	x	
199	x						x	x								x					x		x
200	x						x	x									x		x			x	
201	x						x	x									x		x				x
202	x						x	x									x			x		x	
203	x						x	x									x			x			x
204	x						x	x									x				x	x	
205	x						x	x									x				x		x
206	x						x	x										x	x			x	
207	x						x	x										x	x				x
208	x						x	x										x		x		x	
209	x						x	x										x		x			x
210	x						x	x										x			x	x	
211	x						x	x										x			x		x
212	x						x		x					x					x			x	
213	x						x		x					x					x				x
214	x						x		x					x						x		x	
215	x						x		x					x						x			x
216	x						x		x					x							x	x	
217	x						x		x					x							x		x
218	x						x		x						x				x			x	
219	x						x		x						x				x				x
220	x						x		x						x					x		x	
221	x						x		x						x					x			x
222	x						x		x						x						x	x	
223	x						x		x						x						x		x
224	x						x		x							x			x			x	
225	x						x		x							x			x				x
226	x						x		x							x				x		x	
227	x						x		x							x				x			x
228	x						x		x							x					x	x	
229	x						x		x							x					x		x
230	x						x		x								x		x			x	
231	x						x		x								x		x				x
232	x						x		x								x			x		x	
233	x						x		x								x			x			x
234	x						x		x								x				x	x	
235	x						x		x								x				x		x
236	x						x		x									x	x			x	
237	x						x		x									x	x				x
238	x						x		x									x		x		x	
239	x						x		x									x		x			x
240	x						x		x									x			x	x	
241	x						x		x									x			x		x
242	x						x			x				x					x			x	
243	x						x			x				x					x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
244	x						x			x				x						x		x	
245	x						x			x				x						x			x
246	x						x			x				x							x	x	
247	x						x			x				x							x		x
248	x						x			x					x				x			x	
249	x						x			x					x				x				x
250	x						x			x					x					x		x	
251	x						x			x					x					x			x
252	x						x			x					x						x	x	
253	x						x			x					x						x		x
254	x						x			x						x			x			x	
255	x						x			x						x			x				x
256	x						x			x						x				x		x	
257	x						x			x						x				x			x
258	x						x			x						x					x	x	
259	x						x			x						x					x		x
260	x						x			x							x		x			x	
261	x						x			x							x		x				x
262	x						x			x							x			x		x	
263	x						x			x							x			x			x
264	x						x			x							x				x	x	
265	x						x			x							x				x		x
266	x						x			x								x	x			x	
267	x						x			x								x	x				x
268	x						x			x								x		x		x	
269	x						x			x								x		x			x
270	x						x			x								x			x	x	
271	x						x			x								x			x		x
272	x						x				x			x					x			x	
273	x						x				x			x					x				x
274	x						x				x			x						x		x	
275	x						x				x			x						x			x
276	x						x				x			x							x	x	
277	x						x				x			x							x		x
278	x						x				x				x				x			x	
279	x						x				x				x				x				x
280	x						x				x				x					x		x	
281	x						x				x				x					x			x
282	x						x				x				x						x	x	
283	x						x				x				x						x		x
284	x						x				x					x			x			x	
285	x						x				x					x			x				x
286	x						x				x					x				x		x	
287	x						x				x					x				x			x
288	x						x				x					x					x	x	
289	x						x				x					x					x		x
290	x						x				x						x		x			x	
291	x						x				x						x		x				x
292	x						x				x						x			x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
293	x						x				x						x			x			x
294	x						x				x						x				x	x	
295	x						x				x						x				x		x
296	x						x				x							x	x			x	
297	x						x				x							x	x				x
298	x						x				x							x		x		x	
299	x						x				x							x		x			x
300	x						x				x							x			x	x	
301	x						x				x							x			x		x
302	x						x					x		x					x			x	
303	x						x					x		x					x				x
304	x						x					x		x						x		x	
305	x						x					x		x						x			x
306	x						x					x		x							x	x	
307	x						x					x		x							x		x
308	x						x					x			x				x			x	
309	x						x					x			x				x				x
310	x						x					x			x					x		x	
311	x						x					x			x					x			x
312	x						x					x			x						x	x	
313	x						x					x			x						x		x
314	x						x					x				x			x			x	
315	x						x					x				x			x				x
316	x						x					x				x				x		x	
317	x						x					x				x				x			x
318	x						x					x				x					x	x	
319	x						x					x				x					x		x
320	x						x					x					x		x			x	
321	x						x					x					x		x				x
322	x						x					x					x			x		x	
323	x						x					x					x			x			x
324	x						x					x					x				x	x	
325	x						x					x					x				x		x
326	x						x					x						x	x			x	
327	x						x					x						x	x				x
328	x						x					x						x		x		x	
329	x						x					x						x		x			x
330	x						x					x						x			x	x	
331	x						x					x						x			x		x
332	x						x						x	x					x			x	
333	x						x						x	x					x				x
334	x						x						x	x						x		x	
335	x						x						x	x						x			x
336	x						x						x	x							x	x	
337	x						x						x	x							x		x
338	x						x						x		x				x			x	
339	x						x						x		x				x				x
340	x						x						x		x					x		x	
341	x						x						x		x					x			x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
342	x						x						x		x						x	x	
343	x						x						x		x						x		x
344	x						x						x			x			x			x	
345	x						x						x			x			x				x
346	x						x						x			x				x		x	
347	x						x						x			x				x			x
348	x						x						x			x					x	x	
349	x						x						x			x					x		x
350	x						x						x				x		x			x	
351	x						x						x				x		x				x
352	x						x						x				x			x		x	
353	x						x						x				x			x			x
354	x						x						x				x				x	x	
355	x						x						x				x				x		x
356	x						x						x					x	x			x	
357	x						x						x					x	x				x
358	x						x						x					x		x		x	
359	x						x						x					x		x			x
360	x						x						x					x			x	x	
361	x						x						x					x			x		x
362		x				x		x						x					x			x	
363		x				x		x						x					x				x
364		x				x		x						x						x		x	
365		x				x		x						x						x			x
366		x				x		x						x							x	x	
367		x				x		x						x							x		x
368		x				x		x							x				x			x	
369		x				x		x							x				x				x
370		x				x		x							x					x		x	
371		x				x		x							x					x			x
372		x				x		x							x						x	x	
373		x				x		x							x						x		x
374		x				x		x								x			x			x	
375		x				x		x								x			x				x
376		x				x		x								x				x		x	
377		x				x		x								x				x			x
378		x				x		x								x					x	x	
379		x				x		x								x					x		x
380		x				x		x									x		x			x	
381		x				x		x									x		x				x
382		x				x		x									x			x		x	
383		x				x		x									x			x			x
384		x				x		x									x				x	x	
385		x				x		x									x				x		x
386		x				x		x										x	x			x	
387		x				x		x										x	x				x
388		x				x		x										x		x		x	
389		x				x		x										x		x			x
390		x				x		x										x			x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
391		x				x		x										x			x		x
392		x				x			x					x					x			x	
393		x				x			x					x					x				x
394		x				x			x					x						x		x	
395		x				x			x					x						x			x
396		x				x			x					x							x	x	
397		x				x			x					x							x		x
398		x				x			x						x				x			x	
399		x				x			x						x				x				x
400		x				x			x						x					x		x	
401		x				x			x						x					x			x
402		x				x			x						x						x	x	
403		x				x			x						x						x		x
404		x				x			x							x			x			x	
405		x				x			x							x			x				x
406		x				x			x							x				x		x	
407		x				x			x							x				x			x
408		x				x			x							x					x	x	
409		x				x			x							x					x		x
410		x				x			x								x		x			x	
411		x				x			x								x		x				x
412		x				x			x								x			x		x	
413		x				x			x								x			x			x
414		x				x			x								x				x	x	
415		x				x			x								x				x		x
416		x				x			x									x	x			x	
417		x				x			x									x	x				x
418		x				x			x									x		x		x	
419		x				x			x									x		x			x
420		x				x			x									x			x	x	
421		x				x			x									x			x		x
422		x				x				x				x					x			x	
423		x				x				x				x					x				x
424		x				x				x				x						x		x	
425		x				x				x				x						x			x
426		x				x				x				x							x	x	
427		x				x				x				x							x		x
428		x				x				x					x				x			x	
429		x				x				x					x				x				x
430		x				x				x					x					x		x	
431		x				x				x					x					x			x
432		x				x				x					x						x	x	
433		x				x				x					x						x		x
434		x				x				x						x			x			x	
435		x				x				x						x			x				x
436		x				x				x						x				x		x	
437		x				x				x						x				x			x
438		x				x				x						x					x	x	
439		x				x				x						x					x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
440		x				x				x							x		x			x	
441		x				x				x							x		x				x
442		x				x				x							x			x		x	
443		x				x				x							x			x			x
444		x				x				x							x				x	x	
445		x				x				x							x				x		x
446		x				x				x								x	x			x	
447		x				x				x								x	x				x
448		x				x				x								x		x		x	
449		x				x				x								x		x			x
450		x				x				x								x			x	x	
451		x				x				x								x			x		x
452		x				x					x			x					x			x	
453		x				x					x			x					x				x
454		x				x					x			x						x		x	
455		x				x					x			x						x			x
456		x				x					x			x							x	x	
457		x				x					x			x							x		x
458		x				x					x				x				x			x	
459		x				x					x				x				x				x
460		x				x					x				x					x		x	
461		x				x					x				x					x			x
462		x				x					x				x						x	x	
463		x				x					x				x						x		x
464		x				x					x					x			x			x	
465		x				x					x					x			x				x
466		x				x					x					x				x		x	
467		x				x					x					x				x			x
468		x				x					x					x					x	x	
469		x				x					x					x					x		x
470		x				x					x						x		x			x	
471		x				x					x						x		x				x
472		x				x					x						x			x		x	
473		x				x					x						x			x			x
474		x				x					x						x				x	x	
475		x				x					x						x				x		x
476		x				x					x							x	x			x	
477		x				x					x							x	x				x
478		x				x					x							x		x		x	
479		x				x					x							x		x			x
480		x				x					x							x			x	x	
481		x				x					x							x			x		x
482		x				x						x		x					x			x	
483		x				x						x		x					x				x
484		x				x						x		x						x		x	
485		x				x						x		x						x			x
486		x				x						x		x							x	x	
487		x				x						x		x							x		x
488		x				x						x			x				x			x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
489		x				x						x			x				x				x
490		x				x						x			x					x		x	
491		x				x						x			x					x			x
492		x				x						x			x						x	x	
493		x				x						x			x						x		x
494		x				x						x				x			x			x	
495		x				x						x				x			x				x
496		x				x						x				x				x		x	
497		x				x						x				x				x			x
498		x				x						x				x					x	x	
499		x				x						x				x					x		x
500		x				x						x					x		x			x	
501		x				x						x					x		x				x
502		x				x						x					x			x		x	
503		x				x						x					x			x			x
504		x				x						x					x				x	x	
505		x				x						x					x				x		x
506		x				x						x						x	x			x	
507		x				x						x						x	x				x
508		x				x						x						x		x		x	
509		x				x						x						x		x			x
510		x				x						x						x			x	x	
511		x				x						x						x			x		x
512		x				x							x	x					x			x	
513		x				x							x	x					x				x
514		x				x							x	x						x		x	
515		x				x							x	x						x			x
516		x				x							x	x							x	x	
517		x				x							x	x							x		x
518		x				x							x		x				x			x	
519		x				x							x		x				x				x
520		x				x							x		x					x		x	
521		x				x							x		x					x			x
522		x				x							x		x						x	x	
523		x				x							x		x						x		x
524		x				x							x			x			x			x	
525		x				x							x			x			x				x
526		x				x							x			x				x		x	
527		x				x							x			x				x			x
528		x				x							x			x					x	x	
529		x				x							x			x					x		x
530		x				x							x				x		x			x	
531		x				x							x				x		x				x
532		x				x							x				x			x		x	
533		x				x							x				x			x			x
534		x				x							x				x				x	x	
535		x				x							x				x				x		x
536		x				x							x					x	x			x	
537		x				x							x					x	x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
538		x				x							x					x		x		x	
539		x				x							x					x		x			x
540		x				x							x					x			x	x	
541		x				x							x					x			x		x
542		x					x	x						x					x			x	
543		x					x	x						x					x				x
544		x					x	x						x						x		x	
545		x					x	x						x						x			x
546		x					x	x						x							x	x	
547		x					x	x						x							x		x
548		x					x	x							x				x			x	
549		x					x	x							x				x				x
550		x					x	x							x					x		x	
551		x					x	x							x					x			x
552		x					x	x							x						x	x	
553		x					x	x							x						x		x
554		x					x	x								x			x			x	
555		x					x	x								x			x				x
556		x					x	x								x				x		x	
557		x					x	x								x				x			x
558		x					x	x								x					x	x	
559		x					x	x								x					x		x
560		x					x	x									x		x			x	
561		x					x	x									x		x				x
562		x					x	x									x			x		x	
563		x					x	x									x			x			x
564		x					x	x									x				x	x	
565		x					x	x									x				x		x
566		x					x	x										x	x			x	
567		x					x	x										x	x				x
568		x					x	x										x		x		x	
569		x					x	x										x		x			x
570		x					x	x										x			x	x	
571		x					x	x										x			x		x
572		x					x		x					x					x			x	
573		x					x		x					x					x				x
574		x					x		x					x						x		x	
575		x					x		x					x						x			x
576		x					x		x					x							x	x	
577		x					x		x					x							x		x
578		x					x		x						x				x			x	
579		x					x		x						x				x				x
580		x					x		x						x					x		x	
581		x					x		x						x					x			x
582		x					x		x						x						x	x	
583		x					x		x						x						x		x
584		x					x		x							x			x			x	
585		x					x		x							x			x				x
586		x					x		x							x				x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
587		x					x		x							x				x			x
588		x					x		x							x					x	x	
589		x					x		x							x					x		x
590		x					x		x								x		x			x	
591		x					x		x								x		x				x
592		x					x		x								x			x		x	
593		x					x		x								x			x			x
594		x					x		x								x				x	x	
595		x					x		x								x				x		x
596		x					x		x									x	x			x	
597		x					x		x									x	x				x
598		x					x		x									x		x		x	
599		x					x		x									x		x			x
600		x					x		x									x			x	x	
601		x					x		x									x			x		x
602		x					x			x				x					x			x	
603		x					x			x				x					x				x
604		x					x			x				x						x		x	
605		x					x			x				x						x			x
606		x					x			x				x							x	x	
607		x					x			x				x							x		x
608		x					x			x					x				x			x	
609		x					x			x					x				x				x
610		x					x			x					x					x		x	
611		x					x			x					x					x			x
612		x					x			x					x						x	x	
613		x					x			x					x						x		x
614		x					x			x						x			x			x	
615		x					x			x						x			x				x
616		x					x			x						x				x		x	
617		x					x			x						x				x			x
618		x					x			x						x					x	x	
619		x					x			x						x					x		x
620		x					x			x							x		x			x	
621		x					x			x							x		x				x
622		x					x			x							x			x		x	
623		x					x			x							x			x			x
624		x					x			x							x				x	x	
625		x					x			x							x				x		x
626		x					x			x								x	x			x	
627		x					x			x								x	x				x
628		x					x			x								x		x		x	
629		x					x			x								x		x			x
630		x					x			x								x			x	x	
631		x					x			x								x			x		x
632		x					x				x			x					x			x	
633		x					x				x			x					x				x
634		x					x				x			x						x		x	
635		x					x				x			x						x			x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
636		x					x				x			x							x	x	
637		x					x				x			x							x		x
638		x					x				x				x				x			x	
639		x					x				x				x				x				x
640		x					x				x				x					x		x	
641		x					x				x				x					x			x
642		x					x				x				x						x	x	
643		x					x				x				x						x		x
644		x					x				x					x			x			x	
645		x					x				x					x			x				x
646		x					x				x					x				x		x	
647		x					x				x					x				x			x
648		x					x				x					x					x	x	
649		x					x				x					x					x		x
650		x					x				x						x		x			x	
651		x					x				x						x		x				x
652		x					x				x						x			x		x	
653		x					x				x						x			x			x
654		x					x				x						x				x	x	
655		x					x				x						x				x		x
656		x					x				x							x	x			x	
657		x					x				x							x	x				x
658		x					x				x							x		x		x	
659		x					x				x							x		x			x
660		x					x				x							x			x	x	
661		x					x				x							x			x		x
662		x					x					x		x					x			x	
663		x					x					x		x					x				x
664		x					x					x		x						x		x	
665		x					x					x		x						x			x
666		x					x					x		x							x	x	
667		x					x					x		x							x		x
668		x					x					x			x				x			x	
669		x					x					x			x				x				x
670		x					x					x			x					x		x	
671		x					x					x			x					x			x
672		x					x					x			x						x	x	
673		x					x					x			x						x		x
674		x					x					x				x			x			x	
675		x					x					x				x			x				x
676		x					x					x				x				x		x	
677		x					x					x				x				x			x
678		x					x					x				x					x	x	
679		x					x					x				x					x		x
680		x					x					x					x		x			x	
681		x					x					x					x		x				x
682		x					x					x					x			x		x	
683		x					x					x					x			x			x
684		x					x					x					x				x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
685		x					x					x					x				x		x
686		x					x					x						x	x			x	
687		x					x					x						x	x				x
688		x					x					x						x		x		x	
689		x					x					x						x		x			x
690		x					x					x						x			x	x	
691		x					x					x						x			x		x
692		x					x						x	x					x			x	
693		x					x						x	x					x				x
694		x					x						x	x						x		x	
695		x					x						x	x						x			x
696		x					x						x	x							x	x	
697		x					x						x	x							x		x
698		x					x						x		x				x			x	
699		x					x						x		x				x				x
700		x					x						x		x					x		x	
701		x					x						x		x					x			x
702		x					x						x		x						x	x	
703		x					x						x		x						x		x
704		x					x						x			x			x			x	
705		x					x						x			x			x				x
706		x					x						x			x				x		x	
707		x					x						x			x				x			x
708		x					x						x			x					x	x	
709		x					x						x			x					x		x
710		x					x						x				x		x			x	
711		x					x						x				x		x				x
712		x					x						x				x			x		x	
713		x					x						x				x			x			x
714		x					x						x				x				x	x	
715		x					x						x				x				x		x
716		x					x						x					x	x			x	
717		x					x						x					x	x				x
718		x					x						x					x		x		x	
719		x					x						x					x		x			x
720		x					x						x					x			x	x	
721		x					x						x					x			x		x
722			x			x		x						x					x			x	
723			x			x		x						x					x				x
724			x			x		x						x						x		x	
725			x			x		x						x						x			x
726			x			x		x						x							x	x	
727			x			x		x						x							x		x
728			x			x		x							x				x			x	
729			x			x		x							x				x				x
730			x			x		x							x					x		x	
731			x			x		x							x					x			x
732			x			x		x							x						x	x	
733			x			x		x							x						x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
734			x			x		x								x			x			x	
735			x			x		x								x			x				x
736			x			x		x								x				x		x	
737			x			x		x								x				x			x
738			x			x		x								x					x	x	
739			x			x		x								x					x		x
740			x			x		x									x		x			x	
741			x			x		x									x		x				x
742			x			x		x									x			x		x	
743			x			x		x									x			x			x
744			x			x		x									x				x	x	
745			x			x		x									x				x		x
746			x			x		x										x	x			x	
747			x			x		x										x	x				x
748			x			x		x										x		x		x	
749			x			x		x										x		x			x
750			x			x		x										x			x	x	
751			x			x		x										x			x		x
752			x			x			x					x						x			x	
753			x			x			x					x						x				x
754			x			x			x					x							x		x	
755			x			x			x					x							x			x
756			x			x			x					x								x	x	
757			x			x			x					x								x		x
758			x			x			x						x					x			x	
759			x			x			x						x					x				x
760			x			x			x						x						x		x	
761			x			x			x						x						x			x
762			x			x			x						x							x	x	
763			x			x			x						x							x		x
764			x			x			x							x				x			x	
765			x			x			x							x				x				x
766			x			x			x							x					x		x	
767			x			x			x							x					x			x
768			x			x			x							x						x	x	
769			x			x			x							x						x		x
770			x			x			x								x		x				x	
771			x			x			x								x		x					x
772			x			x			x								x			x			x	
773			x			x			x								x			x				x
774			x			x			x								x					x	x	
775			x			x			x								x					x		x
776			x			x			x									x	x				x	
777			x			x			x									x	x					x
778			x			x			x									x		x			x	
779			x			x			x									x		x				x
780			x			x			x									x				x	x	
781			x			x			x									x				x		x
782			x			x				x				x						x			x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
783			x			x				x				x					x				x
784			x			x				x				x						x		x	
785			x			x				x				x						x			x
786			x			x				x				x							x	x	
787			x			x				x				x							x		x
788			x			x				x					x				x			x	
789			x			x				x					x				x				x
790			x			x				x					x					x		x	
791			x			x				x					x					x			x
792			x			x				x					x						x	x	
793			x			x				x					x						x		x
794			x			x				x						x			x			x	
795			x			x				x						x			x				x
796			x			x				x						x				x		x	
797			x			x				x						x				x			x
798			x			x				x						x					x	x	
799			x			x				x						x					x		x
800			x			x				x							x		x			x	
801			x			x				x							x		x				x
802			x			x				x							x			x		x	
803			x			x				x							x			x			x
804			x			x				x							x				x	x	
805			x			x				x							x				x		x
806			x			x				x								x	x			x	
807			x			x				x								x	x				x
808			x			x				x								x		x		x	
809			x			x				x								x		x			x
810			x			x				x								x			x	x	
811			x			x				x								x			x		x
812			x			x					x			x					x			x	
813			x			x					x			x					x				x
814			x			x					x			x						x		x	
815			x			x					x			x						x			x
816			x			x					x			x							x	x	
817			x			x					x			x							x		x
818			x			x					x				x				x			x	
819			x			x					x				x				x				x
820			x			x					x				x					x		x	
821			x			x					x				x					x			x
822			x			x					x				x						x	x	
823			x			x					x				x						x		x
824			x			x					x					x			x			x	
825			x			x					x					x			x				x
826			x			x					x					x				x		x	
827			x			x					x					x				x			x
828			x			x					x					x					x	x	
829			x			x					x					x					x		x
830			x			x					x						x		x			x	
831			x			x					x						x		x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
832			x			x					x						x			x		x	
833			x			x					x						x			x			x
834			x			x					x						x				x	x	
835			x			x					x						x				x		x
836			x			x					x							x	x			x	
837			x			x					x							x	x				x
838			x			x					x							x		x		x	
839			x			x					x							x		x			x
840			x			x					x							x			x	x	
841			x			x					x							x			x		x
842			x			x						x		x					x			x	
843			x			x						x		x					x				x
844			x			x						x		x						x		x	
845			x			x						x		x						x			x
846			x			x						x		x							x	x	
847			x			x						x		x							x		x
848			x			x						x			x				x			x	
849			x			x						x			x				x				x
850			x			x						x			x					x		x	
851			x			x						x			x					x			x
852			x			x						x			x						x	x	
853			x			x						x			x						x		x
854			x			x						x				x			x			x	
855			x			x						x				x			x				x
856			x			x						x				x				x		x	
857			x			x						x				x				x			x
858			x			x						x				x					x	x	
859			x			x						x				x					x		x
860			x			x						x					x		x			x	
861			x			x						x					x		x				x
862			x			x						x					x			x		x	
863			x			x						x					x			x			x
864			x			x						x					x				x	x	
865			x			x						x					x				x		x
866			x			x						x						x	x			x	
867			x			x						x						x	x				x
868			x			x						x						x		x		x	
869			x			x						x						x		x			x
870			x			x						x						x			x	x	
871			x			x						x						x			x		x
872			x			x							x	x					x			x	
873			x			x							x	x					x				x
874			x			x							x	x						x		x	
875			x			x							x	x						x			x
876			x			x							x	x							x	x	
877			x			x							x	x							x		x
878			x			x							x		x				x			x	
879			x			x							x		x				x				x
880			x			x							x		x					x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
881			x			x							x		x					x			x
882			x			x							x		x						x	x	
883			x			x							x		x						x		x
884			x			x							x			x			x			x	
885			x			x							x			x			x				x
886			x			x							x			x				x		x	
887			x			x							x			x				x			x
888			x			x							x			x					x	x	
889			x			x							x			x					x		x
890			x			x							x				x		x			x	
891			x			x							x				x		x				x
892			x			x							x				x			x		x	
893			x			x							x				x			x			x
894			x			x							x				x				x	x	
895			x			x							x				x				x		x
896			x			x							x					x	x			x	
897			x			x							x					x	x				x
898			x			x							x					x		x		x	
899			x			x							x					x		x			x
900			x			x							x					x			x	x	
901			x			x							x					x			x		x
902			x				x	x						x						x			x	
903			x				x	x						x						x				x
904			x				x	x						x							x		x	
905			x				x	x						x							x			x
906			x				x	x						x								x	x	
907			x				x	x						x								x		x
908			x				x	x							x					x			x	
909			x				x	x							x					x				x
910			x				x	x							x						x		x	
911			x				x	x							x						x			x
912			x				x	x							x							x	x	
913			x				x	x							x							x		x
914			x				x	x								x				x			x	
915			x				x	x								x				x				x
916			x				x	x								x					x		x	
917			x				x	x								x					x			x
918			x				x	x								x						x	x	
919			x				x	x								x						x		x
920			x				x	x									x			x			x	
921			x				x	x									x			x				x
922			x				x	x									x				x		x	
923			x				x	x									x				x			x
924			x				x	x									x					x	x	
925			x				x	x									x					x		x
926			x				x	x										x	x				x	
927			x				x	x										x	x					x
928			x				x	x										x		x			x	
929			x				x	x										x		x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
930			x				x	x										x			x	x	
931			x				x	x										x			x		x
932			x				x		x					x					x			x	
933			x				x		x					x					x				x
934			x				x		x					x						x		x	
935			x				x		x					x						x			x
936			x				x		x					x							x	x	
937			x				x		x					x							x		x
938			x				x		x						x				x			x	
939			x				x		x						x				x				x
940			x				x		x						x					x		x	
941			x				x		x						x					x			x
942			x				x		x						x						x	x	
943			x				x		x						x						x		x
944			x				x		x							x			x			x	
945			x				x		x							x			x				x
946			x				x		x							x				x		x	
947			x				x		x							x				x			x
948			x				x		x							x					x	x	
949			x				x		x							x					x		x
950			x				x		x								x		x			x	
951			x				x		x								x		x				x
952			x				x		x								x			x		x	
953			x				x		x								x			x			x
954			x				x		x								x				x	x	
955			x				x		x								x				x		x
956			x				x		x									x	x			x	
957			x				x		x									x	x				x
958			x				x		x									x		x		x	
959			x				x		x									x		x			x
960			x				x		x									x			x	x	
961			x				x		x									x			x		x
962			x				x			x				x					x			x	
963			x				x			x				x					x				x
964			x				x			x				x						x		x	
965			x				x			x				x						x			x
966			x				x			x				x							x	x	
967			x				x			x				x							x		x
968			x				x			x					x				x			x	
969			x				x			x					x				x				x
970			x				x			x					x					x		x	
971			x				x			x					x					x			x
972			x				x			x					x						x	x	
973			x				x			x					x						x		x
974			x				x			x						x			x			x	
975			x				x			x						x			x				x
976			x				x			x						x				x		x	
977			x				x			x						x				x			x
978			x				x			x						x					x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
979			x				x			x						x					x		x
980			x				x			x							x		x			x	
981			x				x			x							x		x				x
982			x				x			x							x			x		x	
983			x				x			x							x			x			x
984			x				x			x							x				x	x	
985			x				x			x							x				x		x
986			x				x			x								x	x			x	
987			x				x			x								x	x				x
988			x				x			x								x		x		x	
989			x				x			x								x		x			x
990			x				x			x								x			x	x	
991			x				x			x								x			x		x
992			x				x				x			x					x			x	
993			x				x				x			x					x				x
994			x				x				x			x						x		x	
995			x				x				x			x						x			x
996			x				x				x			x							x	x	
997			x				x				x			x							x		x
998			x				x				x				x				x			x	
999			x				x				x				x				x				x
1000			x				x				x				x					x		x	
1001			x				x				x				x					x			x
1002			x				x				x				x						x	x	
1003			x				x				x				x						x		x
1004			x				x				x					x			x			x	
1005			x				x				x					x			x				x
1006			x				x				x					x				x		x	
1007			x				x				x					x				x			x
1008			x				x				x					x					x	x	
1009			x				x				x					x					x		x
1010			x				x				x						x		x			x	
1011			x				x				x						x		x				x
1012			x				x				x						x			x		x	
1013			x				x				x						x			x			x
1014			x				x				x						x				x	x	
1015			x				x				x						x				x		x
1016			x				x				x							x	x			x	
1017			x				x				x							x	x				x
1018			x				x				x							x		x		x	
1019			x				x				x							x		x			x
1020			x				x				x							x			x	x	
1021			x				x				x							x			x		x
1022			x				x					x		x					x			x	
1023			x				x					x		x					x				x
1024			x				x					x		x						x		x	
1025			x				x					x		x						x			x
1026			x				x					x		x							x	x	
1027			x				x					x		x							x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1028			x				x					x			x				x			x	
1029			x				x					x			x				x				x
1030			x				x					x			x					x		x	
1031			x				x					x			x					x			x
1032			x				x					x			x						x	x	
1033			x				x					x			x						x		x
1034			x				x					x				x			x			x	
1035			x				x					x				x			x				x
1036			x				x					x				x				x		x	
1037			x				x					x				x				x			x
1038			x				x					x				x					x	x	
1039			x				x					x				x					x		x
1040			x				x					x					x		x			x	
1041			x				x					x					x		x				x
1042			x				x					x					x			x		x	
1043			x				x					x					x			x			x
1044			x				x					x					x				x	x	
1045			x				x					x					x				x		x
1046			x				x					x						x	x			x	
1047			x				x					x						x	x				x
1048			x				x					x						x		x		x	
1049			x				x					x						x		x			x
1050			x				x					x						x			x	x	
1051			x				x					x						x			x		x
1052			x				x						x	x						x			x	
1053			x				x						x	x						x				x
1054			x				x						x	x							x		x	
1055			x				x						x	x							x			x
1056			x				x						x	x								x	x	
1057			x				x						x	x								x		x
1058			x				x						x		x					x			x	
1059			x				x						x		x					x				x
1060			x				x						x		x						x		x	
1061			x				x						x		x						x			x
1062			x				x						x		x							x	x	
1063			x				x						x		x							x		x
1064			x				x						x			x				x			x	
1065			x				x						x			x				x				x
1066			x				x						x			x					x		x	
1067			x				x						x			x					x			x
1068			x				x						x			x						x	x	
1069			x				x						x			x						x		x
1070			x				x						x				x			x			x	
1071			x				x						x				x			x				x
1072			x				x						x				x				x		x	
1073			x				x						x				x				x			x
1074			x				x						x				x					x	x	
1075			x				x						x				x					x		x
1076			x				x						x					x	x				x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1077			x				x						x					x	x				x
1078			x				x						x					x		x		x	
1079			x				x						x					x		x			x
1080			x				x						x					x			x	x	
1081			x				x						x					x			x		x
1082				x		x		x						x					x			x	
1083				x		x		x						x					x				x
1084				x		x		x						x						x		x	
1085				x		x		x						x						x			x
1086				x		x		x						x							x	x	
1087				x		x		x						x							x		x
1088				x		x		x							x				x			x	
1089				x		x		x							x				x				x
1090				x		x		x							x					x		x	
1091				x		x		x							x					x			x
1092				x		x		x							x						x	x	
1093				x		x		x							x						x		x
1094				x		x		x								x			x			x	
1095				x		x		x								x			x				x
1096				x		x		x								x				x		x	
1097				x		x		x								x				x			x
1098				x		x		x								x					x	x	
1099				x		x		x								x					x		x
1100				x		x		x									x		x			x	
1101				x		x		x									x		x				x
1102				x		x		x									x			x		x	
1103				x		x		x									x			x			x
1104				x		x		x									x				x	x	
1105				x		x		x									x				x		x
1106				x		x		x										x	x			x	
1107				x		x		x										x	x				x
1108				x		x		x										x		x		x	
1109				x		x		x										x		x			x
1110				x		x		x										x			x	x	
1111				x		x		x										x			x		x
1112				x		x			x					x					x			x	
1113				x		x			x					x					x				x
1114				x		x			x					x						x		x	
1115				x		x			x					x						x			x
1116				x		x			x					x							x	x	
1117				x		x			x					x							x		x
1118				x		x			x						x				x			x	
1119				x		x			x						x				x				x
1120				x		x			x						x					x		x	
1121				x		x			x						x					x			x
1122				x		x			x						x						x	x	
1123				x		x			x						x						x		x
1124				x		x			x							x			x			x	
1125				x		x			x							x			x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1126				x		x			x							x				x		x	
1127				x		x			x							x				x			x
1128				x		x			x							x					x	x	
1129				x		x			x							x					x		x
1130				x		x			x								x		x			x	
1131				x		x			x								x		x				x
1132				x		x			x								x			x		x	
1133				x		x			x								x			x			x
1134				x		x			x								x				x	x	
1135				x		x			x								x				x		x
1136				x		x			x									x	x			x	
1137				x		x			x									x	x				x
1138				x		x			x									x		x		x	
1139				x		x			x									x		x			x
1140				x		x			x									x			x	x	
1141				x		x			x									x			x		x
1142				x		x				x				x					x			x	
1143				x		x				x				x					x				x
1144				x		x				x				x						x		x	
1145				x		x				x				x						x			x
1146				x		x				x				x							x	x	
1147				x		x				x				x							x		x
1148				x		x				x					x				x			x	
1149				x		x				x					x				x				x
1150				x		x				x					x					x		x	
1151				x		x				x					x					x			x
1152				x		x				x					x						x	x	
1153				x		x				x					x						x		x
1154				x		x				x						x			x			x	
1155				x		x				x						x			x				x
1156				x		x				x						x				x		x	
1157				x		x				x						x				x			x
1158				x		x				x						x					x	x	
1159				x		x				x						x					x		x
1160				x		x				x							x		x			x	
1161				x		x				x							x		x				x
1162				x		x				x							x			x		x	
1163				x		x				x							x			x			x
1164				x		x				x							x				x	x	
1165				x		x				x							x				x		x
1166				x		x				x								x	x			x	
1167				x		x				x								x	x				x
1168				x		x				x								x		x		x	
1169				x		x				x								x		x			x
1170				x		x				x								x			x	x	
1171				x		x				x								x			x		x
1172				x		x					x			x					x			x	
1173				x		x					x			x					x				x
1174				x		x					x			x						x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1175				x		x					x			x						x			x
1176				x		x					x			x							x	x	
1177				x		x					x			x							x		x
1178				x		x					x				x				x			x	
1179				x		x					x				x				x				x
1180				x		x					x				x					x		x	
1181				x		x					x				x					x			x
1182				x		x					x				x						x	x	
1183				x		x					x				x						x		x
1184				x		x					x					x			x			x	
1185				x		x					x					x			x				x
1186				x		x					x					x				x		x	
1187				x		x					x					x				x			x
1188				x		x					x					x					x	x	
1189				x		x					x					x					x		x
1190				x		x					x						x		x			x	
1191				x		x					x						x		x				x
1192				x		x					x						x			x		x	
1193				x		x					x						x			x			x
1194				x		x					x						x				x	x	
1195				x		x					x						x				x		x
1196				x		x					x							x	x			x	
1197				x		x					x							x	x				x
1198				x		x					x							x		x		x	
1199				x		x					x							x		x			x
1200				x		x					x							x			x	x	
1201				x		x					x							x			x		x
1202				x		x						x		x					x			x	
1203				x		x						x		x					x				x
1204				x		x						x		x						x		x	
1205				x		x						x		x						x			x
1206				x		x						x		x							x	x	
1207				x		x						x		x							x		x
1208				x		x						x			x				x			x	
1209				x		x						x			x				x				x
1210				x		x						x			x					x		x	
1211				x		x						x			x					x			x
1212				x		x						x			x						x	x	
1213				x		x						x			x						x		x
1214				x		x						x				x			x			x	
1215				x		x						x				x			x				x
1216				x		x						x				x				x		x	
1217				x		x						x				x				x			x
1218				x		x						x				x					x	x	
1219				x		x						x				x					x		x
1220				x		x						x					x		x			x	
1221				x		x						x					x		x				x
1222				x		x						x					x			x		x	
1223				x		x						x					x			x			x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1224				x		x						x					x				x	x	
1225				x		x						x					x				x		x
1226				x		x						x						x	x			x	
1227				x		x						x						x	x				x
1228				x		x						x						x		x		x	
1229				x		x						x						x		x			x
1230				x		x						x						x			x	x	
1231				x		x						x						x			x		x
1232				x		x							x	x					x			x	
1233				x		x							x	x					x				x
1234				x		x							x	x						x		x	
1235				x		x							x	x						x			x
1236				x		x							x	x							x	x	
1237				x		x							x	x							x		x
1238				x		x							x		x				x			x	
1239				x		x							x		x				x				x
1240				x		x							x		x					x		x	
1241				x		x							x		x					x			x
1242				x		x							x		x						x	x	
1243				x		x							x		x						x		x
1244				x		x							x			x			x			x	
1245				x		x							x			x			x				x
1246				x		x							x			x				x		x	
1247				x		x							x			x				x			x
1248				x		x							x			x					x	x	
1249				x		x							x			x					x		x
1250				x		x							x				x		x			x	
1251				x		x							x				x		x				x
1252				x		x							x				x			x		x	
1253				x		x							x				x			x			x
1254				x		x							x				x				x	x	
1255				x		x							x				x				x		x
1256				x		x							x					x	x			x	
1257				x		x							x					x	x				x
1258				x		x							x					x		x		x	
1259				x		x							x					x		x			x
1260				x		x							x					x			x	x	
1261				x		x							x					x			x		x
1262				x			x	x						x					x			x	
1263				x			x	x						x					x				x
1264				x			x	x						x						x		x	
1265				x			x	x						x						x			x
1266				x			x	x						x							x	x	
1267				x			x	x						x							x		x
1268				x			x	x							x				x			x	
1269				x			x	x							x				x				x
1270				x			x	x							x					x		x	
1271				x			x	x							x					x			x
1272				x			x	x							x						x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1273				x			x	x							x						x		x
1274				x			x	x								x			x			x	
1275				x			x	x								x			x				x
1276				x			x	x								x				x		x	
1277				x			x	x								x				x			x
1278				x			x	x								x					x	x	
1279				x			x	x								x					x		x
1280				x			x	x									x		x			x	
1281				x			x	x									x		x				x
1282				x			x	x									x			x		x	
1283				x			x	x									x			x			x
1284				x			x	x									x				x	x	
1285				x			x	x									x				x		x
1286				x			x	x										x	x			x	
1287				x			x	x										x	x				x
1288				x			x	x										x		x		x	
1289				x			x	x										x		x			x
1290				x			x	x										x			x	x	
1291				x			x	x										x			x		x
1292				x			x		x					x					x			x	
1293				x			x		x					x					x				x
1294				x			x		x					x						x		x	
1295				x			x		x					x						x			x
1296				x			x		x					x							x	x	
1297				x			x		x					x							x		x
1298				x			x		x						x				x			x	
1299				x			x		x						x				x				x
1300				x			x		x						x					x		x	
1301				x			x		x						x					x			x
1302				x			x		x						x						x	x	
1303				x			x		x						x						x		x
1304				x			x		x							x			x			x	
1305				x			x		x							x			x				x
1306				x			x		x							x				x		x	
1307				x			x		x							x				x			x
1308				x			x		x							x					x	x	
1309				x			x		x							x					x		x
1310				x			x		x								x		x			x	
1311				x			x		x								x		x				x
1312				x			x		x								x			x		x	
1313				x			x		x								x			x			x
1314				x			x		x								x				x	x	
1315				x			x		x								x				x		x
1316				x			x		x									x	x			x	
1317				x			x		x									x	x				x
1318				x			x		x									x		x		x	
1319				x			x		x									x		x			x
1320				x			x		x									x			x	x	
1321				x			x		x									x			x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1322				x			x			x				x					x			x	
1323				x			x			x				x					x				x
1324				x			x			x				x						x		x	
1325				x			x			x				x						x			x
1326				x			x			x				x							x	x	
1327				x			x			x				x							x		x
1328				x			x			x					x				x			x	
1329				x			x			x					x				x				x
1330				x			x			x					x					x		x	
1331				x			x			x					x					x			x
1332				x			x			x					x						x	x	
1333				x			x			x					x						x		x
1334				x			x			x						x			x			x	
1335				x			x			x						x			x				x
1336				x			x			x						x				x		x	
1337				x			x			x						x				x			x
1338				x			x			x						x					x	x	
1339				x			x			x						x					x		x
1340				x			x			x							x		x			x	
1341				x			x			x							x		x				x
1342				x			x			x							x			x		x	
1343				x			x			x							x			x			x
1344				x			x			x							x				x	x	
1345				x			x			x							x				x		x
1346				x			x			x								x	x			x	
1347				x			x			x								x	x				x
1348				x			x			x								x		x		x	
1349				x			x			x								x		x			x
1350				x			x			x								x			x	x	
1351				x			x			x								x			x		x
1352				x			x				x			x					x			x	
1353				x			x				x			x					x				x
1354				x			x				x			x						x		x	
1355				x			x				x			x						x			x
1356				x			x				x			x							x	x	
1357				x			x				x			x							x		x
1358				x			x				x				x				x			x	
1359				x			x				x				x				x				x
1360				x			x				x				x					x		x	
1361				x			x				x				x					x			x
1362				x			x				x				x						x	x	
1363				x			x				x				x						x		x
1364				x			x				x					x			x			x	
1365				x			x				x					x			x				x
1366				x			x				x					x				x		x	
1367				x			x				x					x				x			x
1368				x			x				x					x					x	x	
1369				x			x				x					x					x		x
1370				x			x				x						x		x			x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1371				x			x				x						x		x				x
1372				x			x				x						x			x		x	
1373				x			x				x						x			x			x
1374				x			x				x						x				x	x	
1375				x			x				x						x				x		x
1376				x			x				x							x	x			x	
1377				x			x				x							x	x				x
1378				x			x				x							x		x		x	
1379				x			x				x							x		x			x
1380				x			x				x							x			x	x	
1381				x			x				x							x			x		x
1382				x			x					x		x					x			x	
1383				x			x					x		x					x				x
1384				x			x					x		x						x		x	
1385				x			x					x		x						x			x
1386				x			x					x		x							x	x	
1387				x			x					x		x							x		x
1388				x			x					x			x				x			x	
1389				x			x					x			x				x				x
1390				x			x					x			x					x		x	
1391				x			x					x			x					x			x
1392				x			x					x			x						x	x	
1393				x			x					x			x						x		x
1394				x			x					x				x			x			x	
1395				x			x					x				x			x				x
1396				x			x					x				x				x		x	
1397				x			x					x				x				x			x
1398				x			x					x				x					x	x	
1399				x			x					x				x					x		x
1400				x			x					x					x		x			x	
1401				x			x					x					x		x				x
1402				x			x					x					x			x		x	
1403				x			x					x					x			x			x
1404				x			x					x					x				x	x	
1405				x			x					x					x				x		x
1406				x			x					x						x	x			x	
1407				x			x					x						x	x				x
1408				x			x					x						x		x		x	
1409				x			x					x						x		x			x
1410				x			x					x						x			x	x	
1411				x			x					x						x			x		x
1412				x			x						x	x					x			x	
1413				x			x						x	x					x				x
1414				x			x						x	x						x		x	
1415				x			x						x	x						x			x
1416				x			x						x	x							x	x	
1417				x			x						x	x							x		x
1418				x			x						x		x				x			x	
1419				x			x						x		x				x				x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1420				x			x						x		x					x		x	
1421				x			x						x		x					x			x
1422				x			x						x		x						x	x	
1423				x			x						x		x						x		x
1424				x			x						x			x			x			x	
1425				x			x						x			x			x				x
1426				x			x						x			x				x		x	
1427				x			x						x			x				x			x
1428				x			x						x			x					x	x	
1429				x			x						x			x					x		x
1430				x			x						x				x		x			x	
1431				x			x						x				x		x				x
1432				x			x						x				x			x		x	
1433				x			x						x				x			x			x
1434				x			x						x				x				x	x	
1435				x			x						x				x				x		x
1436				x			x						x					x	x			x	
1437				x			x						x					x	x				x
1438				x			x						x					x		x		x	
1439				x			x						x					x		x			x
1440				x			x						x					x			x	x	
1441				x			x						x					x			x		x
1442					x	x		x						x					x			x	
1443					x	x		x						x					x				x
1444					x	x		x						x						x		x	
1445					x	x		x						x						x			x
1446					x	x		x						x							x	x	
1447					x	x		x						x							x		x
1448					x	x		x							x				x			x	
1449					x	x		x							x				x				x
1450					x	x		x							x					x		x	
1451					x	x		x							x					x			x
1452					x	x		x							x						x	x	
1453					x	x		x							x						x		x
1454					x	x		x								x			x			x	
1455					x	x		x								x			x				x
1456					x	x		x								x				x		x	
1457					x	x		x								x				x			x
1458					x	x		x								x					x	x	
1459					x	x		x								x					x		x
1460					x	x		x									x		x			x	
1461					x	x		x									x		x				x
1462					x	x		x									x			x		x	
1463					x	x		x									x			x			x
1464					x	x		x									x				x	x	
1465					x	x		x									x				x		x
1466					x	x		x										x	x			x	
1467					x	x		x										x	x				x
1468					x	x		x										x		x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1469					x	x		x										x		x			x
1470					x	x		x										x			x	x	
1471					x	x		x										x			x		x
1472					x	x			x					x					x			x	
1473					x	x			x					x					x				x
1474					x	x			x					x						x		x	
1475					x	x			x					x						x			x
1476					x	x			x					x							x	x	
1477					x	x			x					x							x		x
1478					x	x			x						x				x			x	
1479					x	x			x						x				x				x
1480					x	x			x						x					x		x	
1481					x	x			x						x					x			x
1482					x	x			x						x						x	x	
1483					x	x			x						x						x		x
1484					x	x			x							x			x			x	
1485					x	x			x							x			x				x
1486					x	x			x							x				x		x	
1487					x	x			x							x				x			x
1488					x	x			x							x					x	x	
1489					x	x			x							x					x		x
1490					x	x			x								x		x			x	
1491					x	x			x								x		x				x
1492					x	x			x								x			x		x	
1493					x	x			x								x			x			x
1494					x	x			x								x				x	x	
1495					x	x			x								x				x		x
1496					x	x			x									x	x			x	
1497					x	x			x									x	x				x
1498					x	x			x									x		x		x	
1499					x	x			x									x		x			x
1500					x	x			x									x			x	x	
1501					x	x			x									x			x		x
1502					x	x				x				x					x			x	
1503					x	x				x				x					x				x
1504					x	x				x				x						x		x	
1505					x	x				x				x						x			x
1506					x	x				x				x							x	x	
1507					x	x				x				x							x		x
1508					x	x				x					x				x			x	
1509					x	x				x					x				x				x
1510					x	x				x					x					x		x	
1511					x	x				x					x					x			x
1512					x	x				x					x						x	x	
1513					x	x				x					x						x		x
1514					x	x				x						x			x			x	
1515					x	x				x						x			x				x
1516					x	x				x						x				x		x	
1517					x	x				x						x				x			x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1518					x	x				x						x					x	x	
1519					x	x				x						x					x		x
1520					x	x				x							x		x			x	
1521					x	x				x							x		x				x
1522					x	x				x							x			x		x	
1523					x	x				x							x			x			x
1524					x	x				x							x				x	x	
1525					x	x				x							x				x		x
1526					x	x				x								x	x			x	
1527					x	x				x								x	x				x
1528					x	x				x								x		x		x	
1529					x	x				x								x		x			x
1530					x	x				x								x			x	x	
1531					x	x				x								x			x		x
1532					x	x					x			x					x			x	
1533					x	x					x			x					x				x
1534					x	x					x			x						x		x	
1535					x	x					x			x						x			x
1536					x	x					x			x							x	x	
1537					x	x					x			x							x		x
1538					x	x					x				x				x			x	
1539					x	x					x				x				x				x
1540					x	x					x				x					x		x	
1541					x	x					x				x					x			x
1542					x	x					x				x						x	x	
1543					x	x					x				x						x		x
1544					x	x					x					x			x			x	
1545					x	x					x					x			x				x
1546					x	x					x					x				x		x	
1547					x	x					x					x				x			x
1548					x	x					x					x					x	x	
1549					x	x					x					x					x		x
1550					x	x					x						x		x			x	
1551					x	x					x						x		x				x
1552					x	x					x						x			x		x	
1553					x	x					x						x			x			x
1554					x	x					x						x				x	x	
1555					x	x					x						x				x		x
1556					x	x					x							x	x			x	
1557					x	x					x							x	x				x
1558					x	x					x							x		x		x	
1559					x	x					x							x		x			x
1560					x	x					x							x			x	x	
1561					x	x					x							x			x		x
1562					x	x						x		x					x			x	
1563					x	x						x		x					x				x
1564					x	x						x		x						x		x	
1565					x	x						x		x						x			x
1566					x	x						x		x							x	x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1567					x	x						x		x							x		x
1568					x	x						x			x				x			x	
1569					x	x						x			x				x				x
1570					x	x						x			x					x		x	
1571					x	x						x			x					x			x
1572					x	x						x			x						x	x	
1573					x	x						x			x						x		x
1574					x	x						x				x			x			x	
1575					x	x						x				x			x				x
1576					x	x						x				x				x		x	
1577					x	x						x				x				x			x
1578					x	x						x				x					x	x	
1579					x	x						x				x					x		x
1580					x	x						x					x		x			x	
1581					x	x						x					x		x				x
1582					x	x						x					x			x		x	
1583					x	x						x					x			x			x
1584					x	x						x					x				x	x	
1585					x	x						x					x				x		x
1586					x	x						x						x	x			x	
1587					x	x						x						x	x				x
1588					x	x						x						x		x		x	
1589					x	x						x						x		x			x
1590					x	x						x						x			x	x	
1591					x	x						x						x			x		x
1592					x	x							x	x					x			x	
1593					x	x							x	x					x				x
1594					x	x							x	x						x		x	
1595					x	x							x	x						x			x
1596					x	x							x	x							x	x	
1597					x	x							x	x							x		x
1598					x	x							x		x				x			x	
1599					x	x							x		x				x				x
1600					x	x							x		x					x		x	
1601					x	x							x		x					x			x
1602					x	x							x		x						x	x	
1603					x	x							x		x						x		x
1604					x	x							x			x			x			x	
1605					x	x							x			x			x				x
1606					x	x							x			x				x		x	
1607					x	x							x			x				x			x
1608					x	x							x			x					x	x	
1609					x	x							x			x					x		x
1610					x	x							x				x		x			x	
1611					x	x							x				x		x				x
1612					x	x							x				x			x		x	
1613					x	x							x				x			x			x
1614					x	x							x				x				x	x	
1615					x	x							x				x				x		x

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1616					x	x							x					x	x			x	
1617					x	x							x					x	x				x
1618					x	x							x					x		x		x	
1619					x	x							x					x		x			x
1620					x	x							x					x			x	x	
1621					x	x							x					x			x		x
1622					x		x	x						x					x			x	
1623					x		x	x						x					x				x
1624					x		x	x						x						x		x	
1625					x		x	x						x						x			x
1626					x		x	x						x							x	x	
1627					x		x	x						x							x		x
1628					x		x	x							x				x			x	
1629					x		x	x							x				x				x
1630					x		x	x							x					x		x	
1631					x		x	x							x					x			x
1632					x		x	x							x						x	x	
1633					x		x	x							x						x		x
1634					x		x	x								x			x			x	
1635					x		x	x								x			x				x
1636					x		x	x								x				x		x	
1637					x		x	x								x				x			x
1638					x		x	x								x					x	x	
1639					x		x	x								x					x		x
1640					x		x	x									x		x			x	
1641					x		x	x									x		x				x
1642					x		x	x									x			x		x	
1643					x		x	x									x			x			x
1644					x		x	x									x				x	x	
1645					x		x	x									x				x		x
1646					x		x	x										x	x			x	
1647					x		x	x										x	x				x
1648					x		x	x										x		x		x	
1649					x		x	x										x		x			x
1650					x		x	x										x			x	x	
1651					x		x	x										x			x		x
1652					x		x		x					x					x			x	
1653					x		x		x					x					x				x
1654					x		x		x					x						x		x	
1655					x		x		x					x						x			x
1656					x		x		x					x							x	x	
1657					x		x		x					x							x		x
1658					x		x		x						x				x			x	
1659					x		x		x						x				x				x
1660					x		x		x						x					x		x	
1661					x		x		x						x					x			x
1662					x		x		x						x						x	x	
1663					x		x		x						x						x		x
1664					x		x		x							x			x			x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1665					x		x		x							x			x				x
1666					x		x		x							x				x		x	
1667					x		x		x							x				x			x
1668					x		x		x							x					x	x	
1669					x		x		x							x					x		x
1670					x		x		x								x		x			x	
1671					x		x		x								x		x				x
1672					x		x		x								x			x		x	
1673					x		x		x								x			x			x
1674					x		x		x								x				x	x	
1675					x		x		x								x				x		x
1676					x		x		x									x	x			x	
1677					x		x		x									x	x				x
1678					x		x		x									x		x		x	
1679					x		x		x									x		x			x
1680					x		x		x									x			x	x	
1681					x		x		x									x			x		x
1682					x		x			x				x					x			x	
1683					x		x			x				x					x				x
1684					x		x			x				x						x		x	
1685					x		x			x				x						x			x
1686					x		x			x				x							x	x	
1687					x		x			x				x							x		x
1688					x		x			x					x				x			x	
1689					x		x			x					x				x				x
1690					x		x			x					x					x		x	
1691					x		x			x					x					x			x
1692					x		x			x					x						x	x	
1693					x		x			x					x						x		x
1694					x		x			x						x			x			x	
1695					x		x			x						x			x				x
1696					x		x			x						x				x		x	
1697					x		x			x						x				x			x
1698					x		x			x						x					x	x	
1699					x		x			x						x					x		x
1700					x		x			x							x		x			x	
1701					x		x			x							x		x				x
1702					x		x			x							x			x		x	
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1704					x		x			x							x				x	x	
1705					x		x			x							x				x		x
1706					x		x			x								x	x			x	
1707					x		x			x								x	x				x
1708					x		x			x								x		x		x	
1709					x		x			x								x		x			x
1710					x		x			x								x			x	x	
1711					x		x			x								x			x		x
1712					x		x				x			x					x			x	
1713					x		x				x			x					x				x

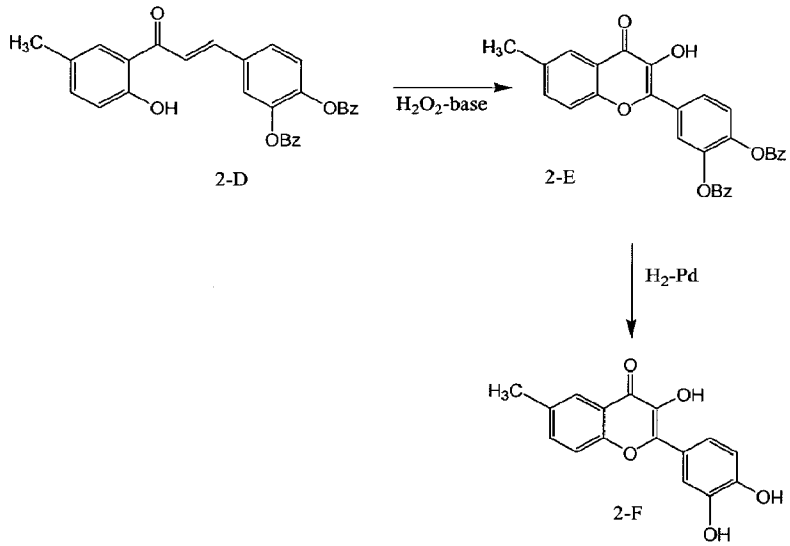
Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1714					x		x				x			x						x		x	
1715					x		x				x			x						x			x
1716					x		x				x			x							x	x	
1717					x		x				x			x							x		x
1718					x		x				x				x				x			x	
1719					x		x				x				x				x				x
1720					x		x				x				x					x		x	
1721					x		x				x				x					x			x
1722					x		x				x				x						x	x	
1723					x		x				x				x						x		x
1724					x		x				x					x			x			x	
1725					x		x				x					x			x				x
1726					x		x				x					x				x		x	
1727					x		x				x					x				x			x
1728					x		x				x					x					x	x	
1729					x		x				x					x					x		x
1730					x		x				x						x		x			x	
1731					x		x				x						x		x				x
1732					x		x				x						x			x		x	
1733					x		x				x						x			x			x
1734					x		x				x						x				x	x	
1735					x		x				x						x				x		x
1736					x		x				x							x	x			x	
1737					x		x				x							x	x				x
1738					x		x				x							x		x		x	
1739					x		x				x							x		x			x
1740					x		x				x							x			x	x	
1741					x		x				x							x			x		x
1742					x		x					x		x					x			x	
1743					x		x					x		x					x				x
1744					x		x					x		x						x		x	
1745					x		x					x		x						x			x
1746					x		x					x		x							x	x	
1747					x		x					x		x							x		x
1748					x		x					x			x				x			x	
1749					x		x					x			x				x				x
1750					x		x					x			x					x		x	
1751					x		x					x			x					x			x
1752					x		x					x			x						x	x	
1753					x		x					x			x						x		x
1754					x		x					x				x			x			x	
1755					x		x					x				x			x				x
1756					x		x					x				x				x		x	
1757					x		x					x				x				x			x
1758					x		x					x				x					x	x	
1759					x		x					x				x					x		x
1760					x		x					x					x		x			x	
1761					x		x					x					x		x				x
1762					x		x					x					x			x		x	

Sub-class #	R_2					R_6		R_8						R_{16}					R_{17}			R_{18}	
1	H	OH	E	K	L	H	OH	H	F	E	K	L	Me	H	Me	G	J	V	H	OMe	K	H	OH
1763					x		x					x					x			x			x
1764					x		x					x					x				x	x	
1765					x		x					x					x				x		x
1766					x		x					x						x	x			x	
1767					x		x					x						x	x				x
1768					x		x					x						x		x		x	
1769					x		x					x						x		x			x
1770					x		x					x						x			x	x	
1771					x		x					x						x			x		x
1772					x		x						x	x					x			x	
1773					x		x						x	x					x				x
1774					x		x						x	x						x		x	
1775					x		x						x	x						x			x
1776					x		x						x	x							x	x	
1777					x		x						x	x							x		x
1778					x		x						x		x				x			x	
1779					x		x						x		x				x				x
1780					x		x						x		x					x		x	
1781					x		x						x		x					x			x
1782					x		x						x		x						x	x	
1783					x		x						x		x						x		x
1784					x		x						x			x			x			x	
1785					x		x						x			x			x				x
1786					x		x						x			x				x		x	
1787					x		x						x			x				x			x
1788					x		x						x			x					x	x	
1789					x		x						x			x					x		x
1790					x		x						x				x		x			x	
1791					x		x						x				x		x				x
1792					x		x						x				x			x		x	
1793					x		x						x				x			x			x
1794					x		x						x				x				x	x	
1795					x		x						x				x				x		x
1796					x		x						x					x	x			x	
1797					x		x						x					x	x				x
1798					x		x						x					x		x		x	
1799					x		x						x					x		x			x
1800					x		x						x					x			x	x	
1801					x		x						x					x			x		x

V. EXAMPLES

Example 1: Synthesis of Compound 2-F.

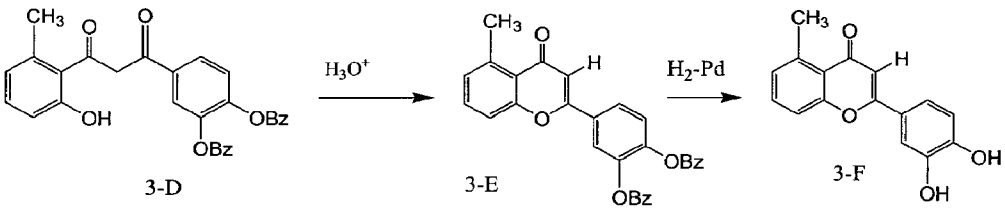
Scheme 5. The synthesis of Pyrone analog 2-F is depicted.



[00822] The synthesis of compound 2-F is shown in Scheme 5. Vinylogous ketone 2-D is cyclized in the presence of hydrogen peroxide and base to form the dibenzyl protected flavonoid 2-E. Hydrogenolysis with hydrogen with palladium catalysis deprotects the benzyl ethers to yield the 3', 4' -dihydroxy phenyl pyrone analog 2-F.

Example 2: Synthesis of Compound 3-F.

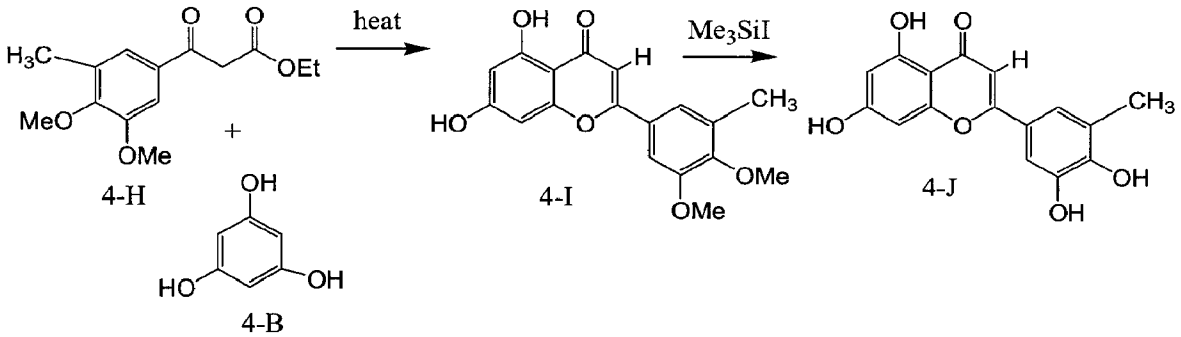
Scheme 6. The synthesis of pyrone analog 3-F is depicted.



[00823] The synthesis of pyrone analog 3-F is accomplished via synthetic steps as shown in Scheme 6. Propanedione 3-D is cyclized under acidic conditions to yield the 3-H dibenzyloxy flavone analog. Deprotection of the benzyl ethers via hydrogenolysis produces pyrone analog 3-F.

Example 3: Synthesis of Compound 4-J.

Scheme 7. The synthesis of Compound 4-J is depicted.



[00824] The trihydroxy benzene 4-B is condensed with propanedione 4-H to obtain the 3', 4' -dimethoxy phenyl flavone 4-I. Deprotection of the methyl ethers at the 3' and 4' positions with trimethylsilyl iodide produces pyrone analog 4-J.

Example 4: Reversal effect of modulator, Pyrone Analog (PA), on sedative effects in rodents

[00825] An anesthetic wake up test is used to assess the reversal effect of modulator, PA, on the sedative effects of barbiturates, opioids, and benzodiazepines. This is a single blind, randomized, controlled animal trial. Approximately 48 rodents may be utilized throughout the study. Animals may be reused. However, a washout of 24 hours is required between exposures.

[00826] Twelve rodents can be utilized in each portion of this trial. Intravenous barbiturate (e.g. diprivan, pentobarbital, or phenobarbital) anesthesia is induced and titrated to spontaneous but slow respirations and lack of response to painful stimulation. Supplemental oxygen may be delivered. A maximum of 3 doses of intraperitoneal PA may be tested (low, medium, high) along with placebo. Once administered rodents are monitored with the help of stopwatch for time to awakening and return to normal respiratory rate. Once awakened, rodents are tested for criteria including time to withdrawal from painful stimulus and performance on rotarod.

[00827] This study may be repeated as a single agent trial with opioids (remifentanyl, fentanyl, morphine, etc) and benzodiazepines (diazepam, midazolam, lorazepam). This study can also be repeated as a multi agent trial utilizing one opioid, one benzodiazepine, and one barbiturate.

Example 5: Pyrone Analog (PgP Modulator) Ameliorates CNS Effects of Oxycodone in an Acute Pain Model

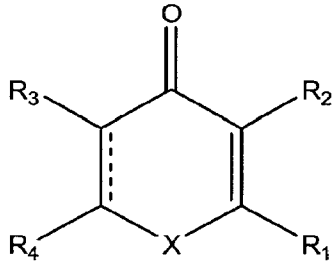
[00828] Opioids frequently produce adverse CNS side effects in ambulatory settings, providing a rationale for improving opioid analgesia by minimizing adverse effects. Pyrone analogs may activate PgP efflux of pump ligands at the blood brain barrier. In this pilot study, the hypothesis that pyrone analogs can improve the tolerability and safety of oxycodone without impairing analgesia is tested. Healthy subjects (up to approximately 65 individuals) undergoing third molar removal are randomly allocated to receive, for example, 500 mg oral PA or matching placebo at 1 hr prior to surgery. All subjects receive, for example, 10 mg oral oxycodone immediately prior to surgery. Oxycodone concentrations do not differ between groups prior to surgery, at 1 hr, or at 4 hr. Total Nausea and Vomiting Score (TNVS) is calculated for the time from dosing through 24 hr.

[00829] All of the methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. It will be apparent to those of skill in the art that variations may be applied without departing from the concept, spirit and scope of the invention. More specifically, it will be apparent that certain

agents that both chemically and physiologically related may be substituted for the agents described herein while the same or similar results would be achieved. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope and concept of the invention as defined by the appended claims.

CLAIMS

1. A compound of Formula I :



Formula I

and its pharmaceutically acceptable salts or esters,

wherein X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

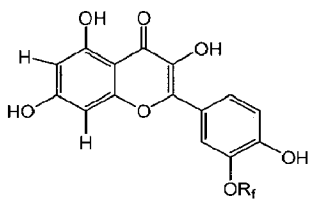
R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_3 and R_4 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, Carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

or R_3 and R_4 are taken together to form a C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, aryl, or heteroaryl;

W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation; and

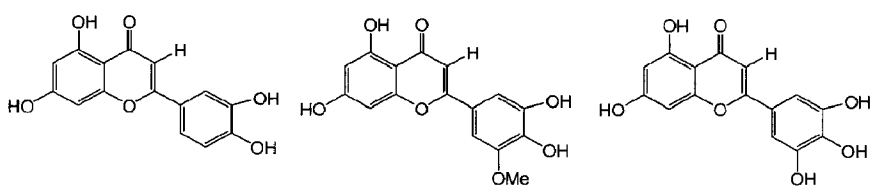
wherein the compound of Formula I is not the compound of Formula A:

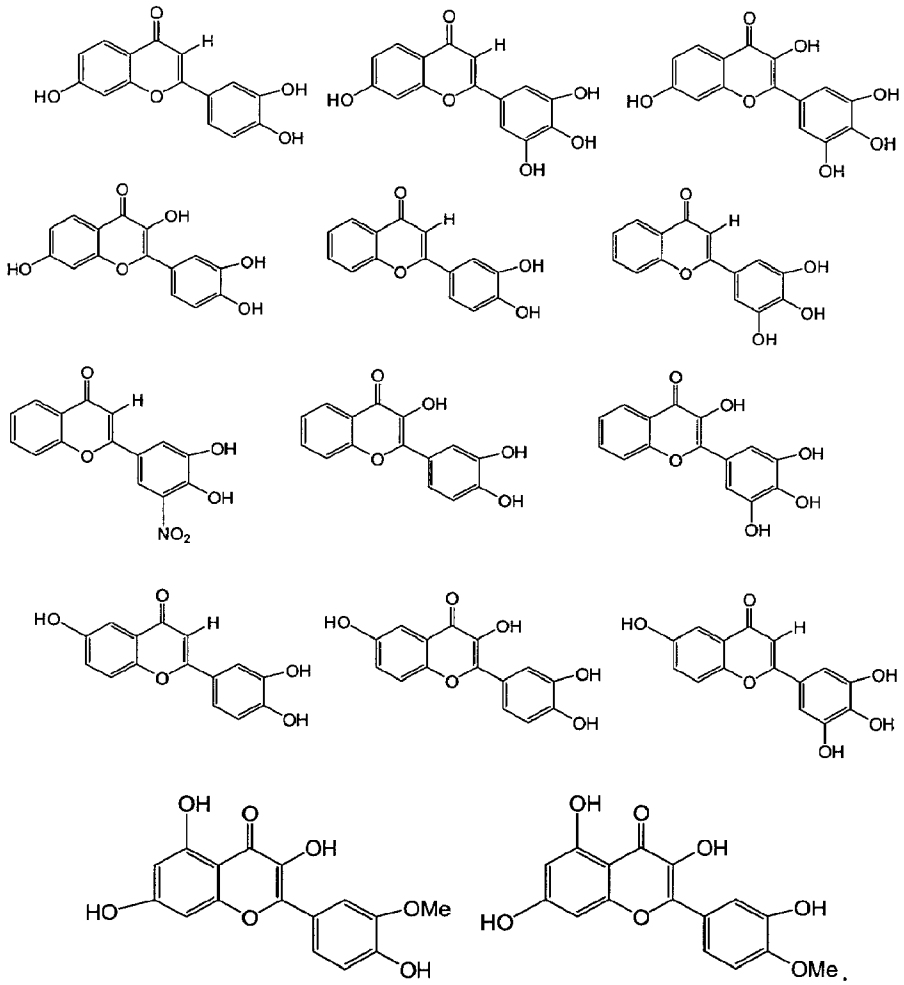


Formula A

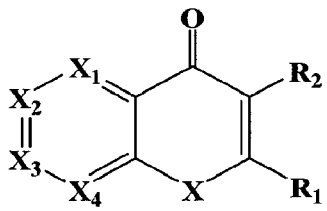
wherein R_f is hydrogen; and

wherein the compound of Formula I is not one of the following compounds:





2. The compound of claim 1 wherein the compound is of Formula II:



Formula II

wherein X_1, X_2, X_3, and X_4 are independently CR_5, O, S, or N; and

each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, Carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

3. The compound of claim 1 or 2 wherein X is O.

4. The compound of claim 2 wherein

X_1, X_2, X_3, and X_4 are CR_5;

X_1 is N, and X_2, X_3, and X_4 are CR_5;

X_2 is N, and X_1, X_3, and X_4 are CR_5;

X_3 is N, and X_1, X_2, and X_4 are CR_5;

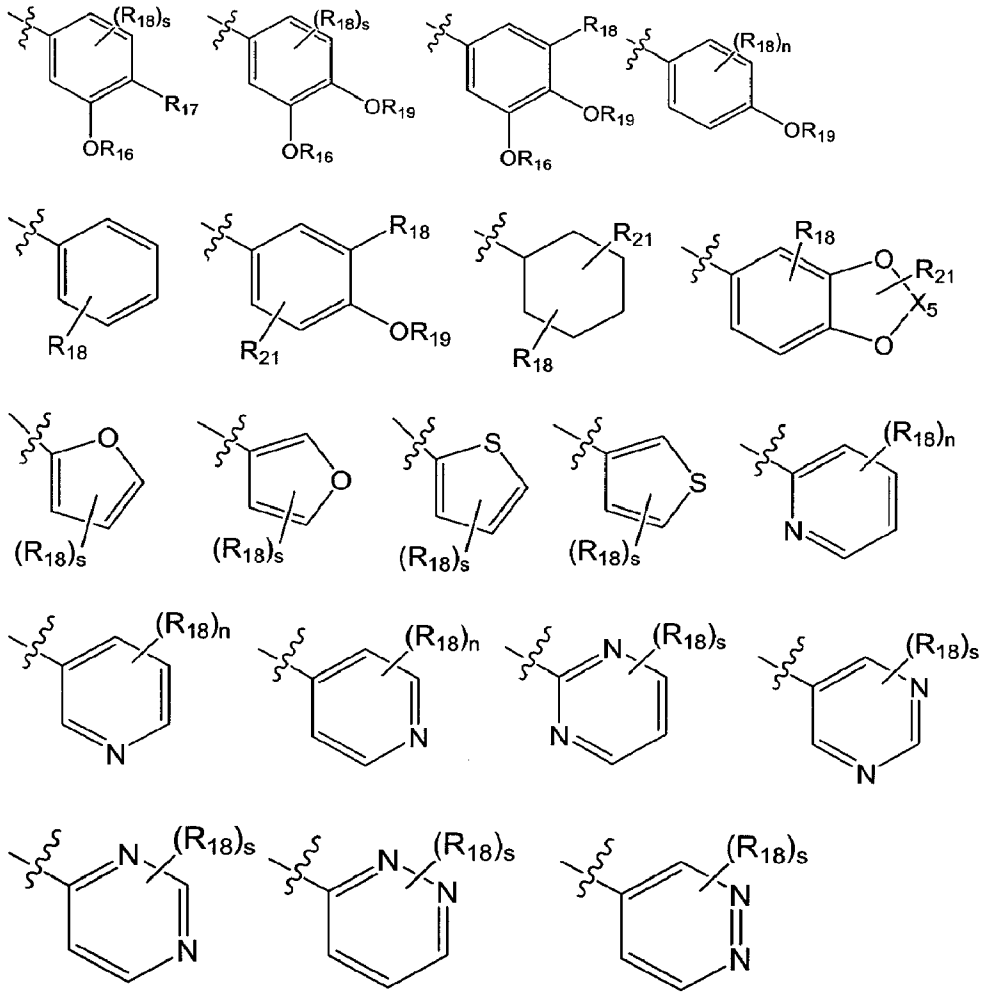
X_4 is N, and X_1, X_2, and X_3 are CR_5;

X_1 and X_3 are CR_5 and X_2 and X_4 are N;

X_2 and X_4 are CR_5 and X_1 and X_3 are N; or

X_2 and X_3 are CR_5 and X_1 and X_4 are N.

5. The compound of claim 1 or 2, wherein R_1 is one of the following formulae:



wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

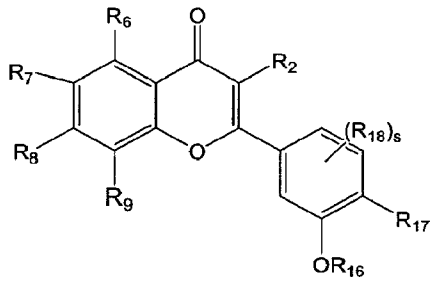
each instance of R_{18} and R_{21} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

s is an integer of 0, 1, 2, or 3; and

n is an integer of 0, 1, 2, 3, or 4.

6. A compound of Formula VII:



Formula VII

and its pharmaceutically acceptable salts thereof, wherein

R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_6, R_7, R_8, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

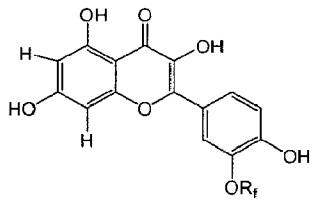
R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

s is an integer of 0, 1, 2, or 3; and

wherein the compound of Formula I is not the compound of Formula A:



Formula A

wherein R_f is hydrogen; and

wherein the compound of Formula VII is not the compound wherein:

R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

R_2 is hydrogen, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- nitro;

R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

R_2 is hydroxy, R_6, R_7, R_8, and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'- hydroxy;

R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

R_2 is hydrogen, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-methoxy;

R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is methyl, R_{17} is hydroxy, and s is 0;

R_2 is hydroxy, R_6 and R_8 are hydroxy, R_7 and R_9 are hydrogen, R_{16} is hydrogen, R_{17} is methoxy, and s is 0;

R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

R_2 is hydrogen, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

R_2 is hydroxy, R_6, R_8, and R_9 are hydrogen, R_7 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0;

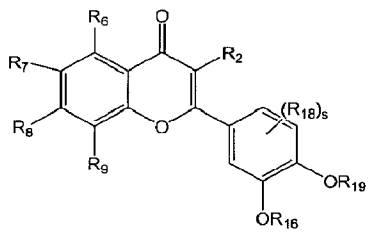
R_2 is hydrogen, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy;

R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, and s is 0; or

R_2 is hydroxy, R_6, R_7, and R_9 are hydrogen, R_8 is hydroxy, R_{16} is hydrogen, R_{17} is hydroxy, s is 1, and R_{18} is 5'-hydroxy.

7. The compound of claim 1 or 6 wherein the compound is not the compound of Formula A wherein R_f is PO_3K_2.

8. The compound of claim 6 of Formula VIII:

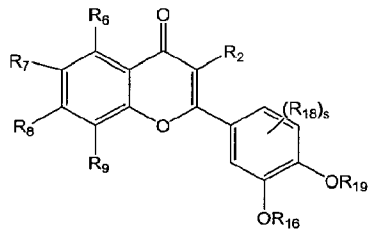


Formula VIII

wherein R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

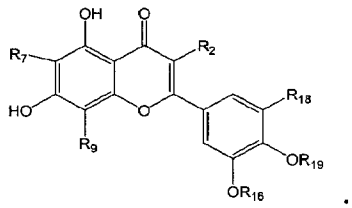
9. The compound of claim 6 of Formula IX:



Formula IX

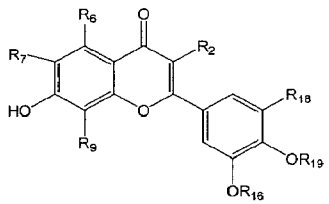
wherein R_6, R_7, R_8, and R_9 are independently hydrogen, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

10. The compound of claim 6 of Formula X:



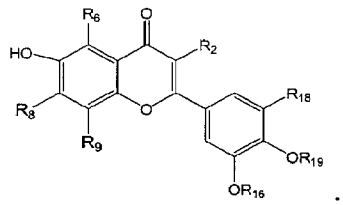
Formula X

11. The compound of claim 6 of Formula XI:



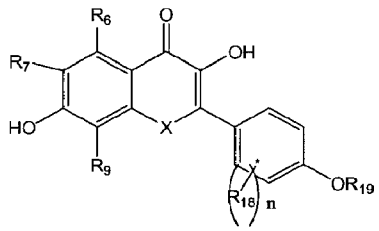
Formula XI

12. The compound of claim 6 of Formula XII:



Formula XII

13. The compound of claim 1 of Formula XIII:



Formula XIII

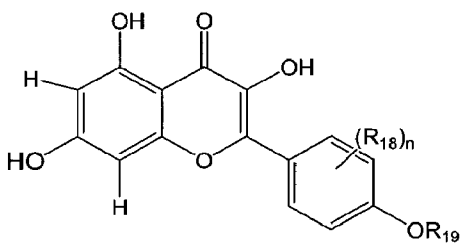
wherein R_6, R_7, and R_9 are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

n is an integer of 0, 1, 2, 3, or 4.

14. The compound of claim 1 of Formula XV:



Formula XV

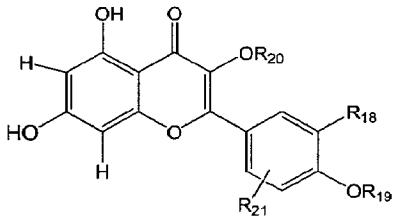
wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate,

aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, -PO_3WY, -CH_2PO_4WY, -CH_2PO_4Z or -PO_3Z; and

n is an integer of 0, 1, 2, 3, or 4.

15. The compound of claim 1 of Formula XVI:

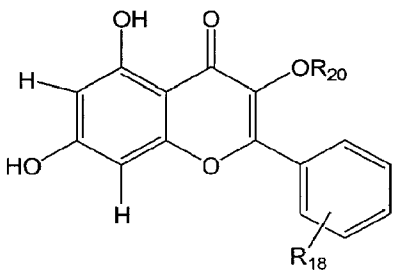


Formula XVI

wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

R_{19} and R_{20} are independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, -PO_3WY, -CH_2PO_4WY, -CH_2PO_4Z or -PO_3Z.

16. The compound of claim 1 of Formula XVII:

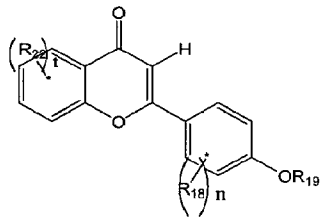


Formula XVII

wherein R_{18} is hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, -OPO_3WY, -OCH_2PO_4WY, -OCH_2PO_4Z or -OPO_3Z;

R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, -PO_3WY, -CH_2PO_4WY, -CH_2PO_4Z or -PO_3Z.

17. The compound of claim 1 of Formula XVIII:



Formula XVIII

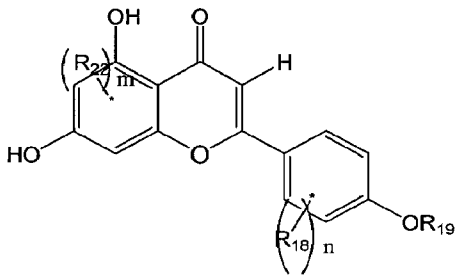
wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

n is an integer of 0, 1, 2, 3, or 4; and

t is an integer of 0, 1, 2, 3, or 4.

18. The compound of claim 1 of Formula XIX:



Formula XIX

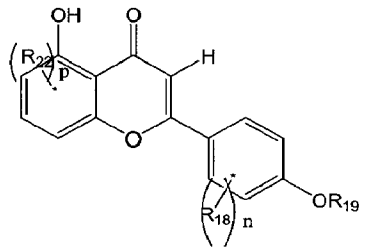
wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

n is an integer of 0, 1, 2, 3, or 4; and

m is an integer of 0, 1, or 2.

19. The compound of claim 1 of Formula XX:



Formula XX

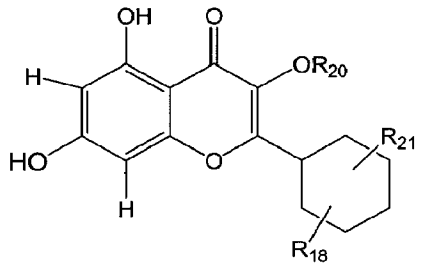
wherein each instance of R_{18} and R_{22} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

n is an integer of 0, 1, 2, 3, or 4; and

p is an integer of 0, 1, 2 or 3.

20. The compound of claim 1 of Formula XXI:

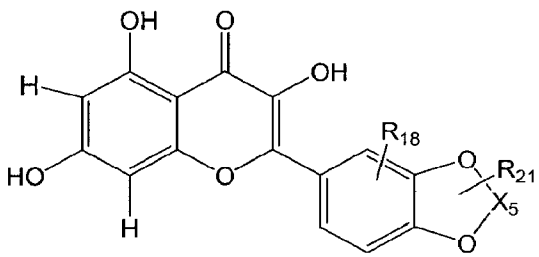


Formula XXI

wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

21. The compound of claim 1 of Formula XXII:



Formula XXII

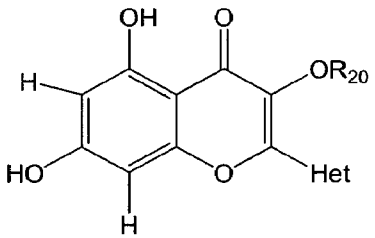
wherein X_5 is a C_1 to C_4 group, optionally interrupted by O, S, NR_{23}, or $NR_{23}R_{23}$ as valency permits, forming a ring which is aromatic or nonaromatic;

wherein R_{18} and R_{21} are independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

each instance of R_{23} is independently hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, acyloxy, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, heteroaryl, C_5-C_{10}heterocyclyl, , C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

wherein when X_5 is a C_1 group, at least one of R_{18} and R_{22} is not hydrogen.

22. The compound of claim 1 of Formula XXIII:



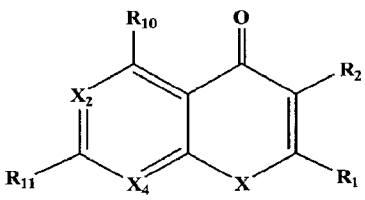
Formula XXIII

R_{20} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

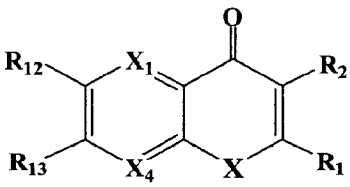
Het is a 3 to 10 membered optionally substituted monocyclic or bicyclic heteroaromatic or heteroalicyclic ring system containing 1, 2, 3, 4, or 5 heteroatoms selected from the group of O, S, and N, with the proviso that no two adjacent ring atoms are O or S, wherein the ring system is unsaturated, partially unsaturated or saturated, wherein any number of the ring atoms have substituents as valency permits which are hydrogen, hydroxyl, carboxaldehyde, alkylcarboxaldehyde, imino, C_1-C_{10} alkyl, C_1-C_{10} alkynyl, C_1-C_{10} alkenyl, carboxyl, carbohydrate, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_5-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, heteroaryl, C_5-C_{10}heterocyclyl, C_5-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

23. The compound of claim 22 wherein Het is selected from the group consisting of optionally substituted furyl, optionally substituted pyridyl, optionally substituted pyridazinyl, optionally substituted pyrimidinyl and optionally substituted thienyl.

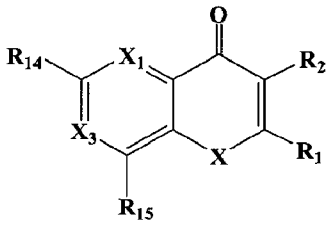
24. A compound of Formula IV, V, or VI:



Formula IV



Formula V



Formula VI

and its pharmaceutically acceptable salts thereof, wherein

X is O, S, or NR', wherein R' is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl;

R_1, and R_2 are independently hydrogen, hydroxyl, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_4-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

each of X_1, X_2, X_3 and X_4 are independently CR_5, O, S, or N, with the proviso that at least one of X_1, X_2, X_3 and X_4 is N;

each instance of R_5 is independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{10}, R_{11} , R_{12} , R_{13}, R_{14} and R_{15} are independently hydrogen, hydroxyl, carboxaldehyde, amino, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, amine, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

W and Y are independently hydrogen, methyl, ethyl, alkyl, carbohydrate, or a cation, and Z is a multivalent cation.

25. The compound of claim 24 wherein X is O.

26. The compound of claim 24 wherein

X_1 is CR_5, and X_3 is N;

X_1 is CR_5, and X_4 is N;

X_2 is CR_5, and X_4 is N;

X_1 is N, and X_3 is CR_5;

X_1 is N, and X_4 is CR_5;

X_2 is CR_5, and X_4 is N;

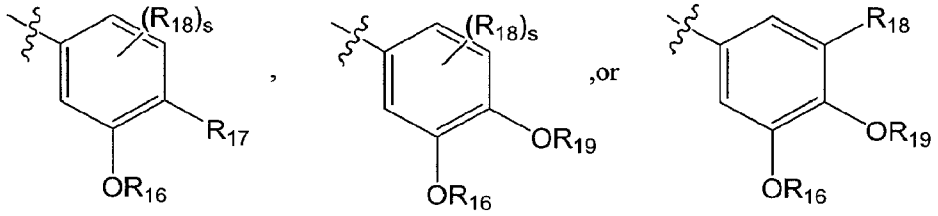
X_1 is CR_5, and X_3 is N;

X_1 and X_3 are N;

X_1 and X_4 are N; or

X_2 and X_4 are N.

27. The compound of claim 24 wherein R_1 is



wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

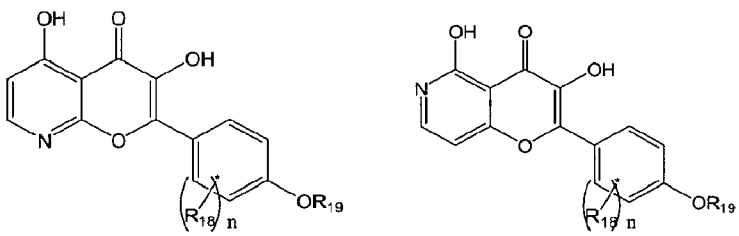
R_{17} is hydrogen, hydroxy, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, aryl, C_3-C_{10} heterocyclyl, heteroaryl, or C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

s is an integer of 0, 1, 2, or 3.

28. The compound of claim 24 of Formula XXIV or Formula XXV:



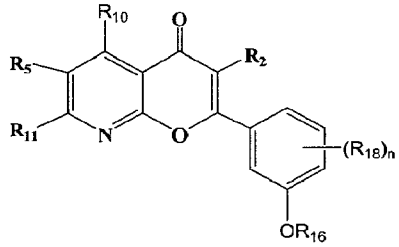
Formula XXIV **Formula XXV**

wherein each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$;

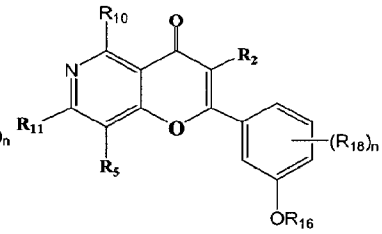
R_{19} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, optionally substituted C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$; and

n is an integer of 0, 1, 2, 3, or 4.

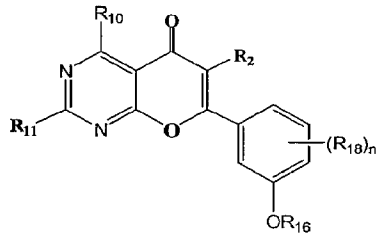
29. The compound of claim 24 of Formula XXVI, Formula XXVII, or Formula XXVIII:



Formula XXVI



Formula XXVII



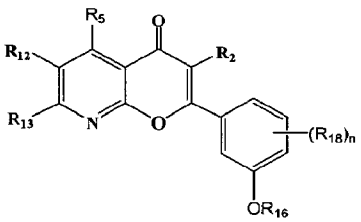
Formula XXVIII

wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

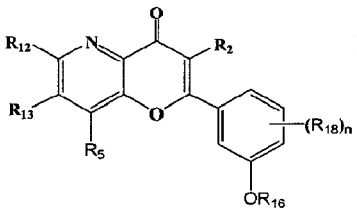
each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

n is an integer of 0, 1, 2, 3, or 4.

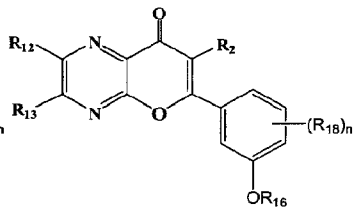
30. The compound of claim 24 of Formula XXIX, Formula XXX, or Formula XXXI;



Formula XXIX



Formula XXX



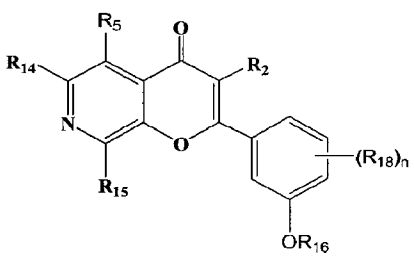
Formula XXXI

wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

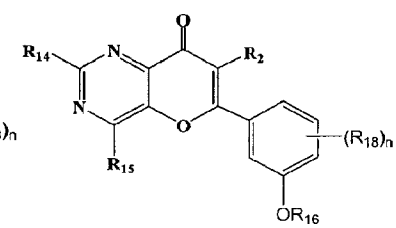
each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

n is an integer of 0, 1, 2, 3, or 4.

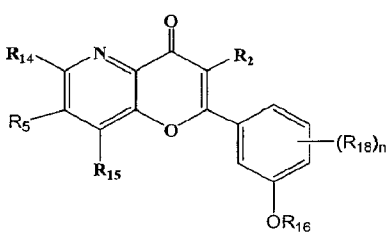
31. The compound of claim 24 of Formula XXXII, Formula XXXIII, or Formula XXXIV:



Formula XXXII



Formula XXXIII



Formula XXXIV

wherein R_{16} is hydrogen, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carbohydrate, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, aryl, C_3-C_{10} heterocyclyl, heteroaryl, C_3-C_{10}cycloalkyl, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$;

each instance of R_{18} is independently hydrogen, hydroxyl, carboxaldehyde, amine, C_1-C_{10} alkyl, C_2-C_{10} alkynyl, C_2-C_{10} alkenyl, carboxyl, carbohydrate, ester, acyloxy, nitro, halogen, C_1-C_{10} aliphatic acyl, C_6-C_{10} aromatic acyl, C_6-C_{10} aralkyl acyl, C_6-C_{10} alkylaryl acyl, alkoxy, alkyl, phosphate, aryl, heteroaryl, C_3-C_{10} heterocyclic, C_3-C_{10}cycloalkyl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$; and

n is an integer of 0, 1, 2, 3, or 4.

32. The compound of claim 1, 6,or 24 wherein R_2 is -H, -OH, $-OCH_2CH_3$, or $-OCH_3$.

33. The compound of claim 2, 24, 29, 30 or 31 wherein R_5 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

34. The compound of claim 6, 8, 9, 11, 12, or 13 wherein R_6 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, or -Cl.

35. The compound of claim 6, 8, 9, 11, or 13 wherein R_7 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, or -Cl.

36. The compound of claim 6, 8, 9, 10, or 12 wherein R_8 is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, -O-glucoronide, or -Cl.

37. The compound of claim 6, 8, 9, 10, 11, 12, or 13 wherein R_9 is -H, -OH, $-OCH_2CH_3$, or $-OCH_3$.

38. The compound of claim 29 wherein R_{10} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

39. The compound of claim 29 wherein R_{11} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

40. The compound of claim 30,wherein R_{12} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

41. The compound of claim 30 wherein R_{13} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

42. The compound of claim 31 wherein R_{14} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

43. The compound of claim 31 wherein R_{15} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$ or -Cl.

44. The compound of claim 1, 6, or 24 wherein R_{16} is hydrogen, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

45. The compound of claim 5, 6, or 27 wherein R_{17} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

46. The compound of claim 5, 6, 27, 28, 29, 30, or 31 wherein R_{18} is -H, $-CH_3$, $-CH_2CH_3$, $-OCH_2CH_3$, $-OCH_3$, –Cl, $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

47. The compound of claim 5, 6, 27, 28, 29, 30, or 31 wherein R_{19} is –H, $-CH_3$, $-CH_2CH_3$, $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$.

48. The compound of claim 1, 6, or 24 wherein WY is H_2, Na_2, or K_2.

49. The compound of claim 1, 6, or 24 wherein Z is Ca or Mg.

50. The compound of claim 6, 27, 28, 29, 30 or 31 wherein at least one of R_{16} and R_{19} is $-PO_3WY$, $-CH_2PO_4WY$, $-CH_2PO_4Z$ or $-PO_3Z$, or R_{18} is $-OPO_3WY$, $-OCH_2PO_4WY$, $-OCH_2PO_4Z$ or $-OPO_3Z$.

51. A pharmaceutical composition comprising a compound of claim 1, 6, or 24 and a pharmaceutically acceptable carrier.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/71606

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A01N 43/16; A61K 31/35 (2008.04)
USPC - 514/456
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC - 514/456

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 514/457, 460; 549/283, 285 (text search - see search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST (USPT, PGPB, EPAB, JPAB) and Google Web/Patent/Scholar
Search terms: pyrone, flavonoid, phosphoryl$, enhance NEAR5 (effectiveness OR efficacy), reduc$4 NEAR5 "side effects"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	Beutler et al. Structure-Activity Requirements for Flavone Cytotoxicity and Binding to Tubulin. Journal of Medicinal Chemistry, 1998, Vol 41, pp 2333-2338, pg 2334, Tables 1-3	1-7, 9-19 --- 20-23, 34-37
X	US 2004/0235081 A1 (Burton et al.) 25 November 2004 (25.11.2004) para [0101], Example 4	6, 8
X --- Y	WO 2007/016525 A2 (Johansson et al.) 08 February 2007 (08.02.2007) para [0076], [0092]-[0093], [0116], [0165]	24-33, 38-51 --- 34-37
Y	Hu et al. ANTI-AIDS AGENTS, 10.' ACACETIN-7-O-B-D-GALACTOPYRANOSIDE, AN ANTI-HIV PRINCIPLE FROM CHRYSANTHEMUM MORIFOLIUM AND A STRUCTURE-ACTIVITY CORRELATION WITH SOME RELATED FLAVONOIDS. Journal of Natural Products, 1994, Vol 57, No 1, pp. 42-51, pg 42, para 1, pg 46, Table 3	20
Y	US 2002/0106338 A1 (Pfluecker et al.) 08 August 2002 (08.08.2002) para [0013], [0136]	21
Y	Katsuyama et al. Synthesis of Unnatural Flavonoids and Stilbenes by Exploiting the Plant Biosynthetic Pathway in Escherichia coli. Chemistry and Biology, June 2007, Vol 14, pp 613-621, pg 616, Fig 2, pg 619, para 3	22-23

☐ Further documents are listed in the continuation of Box C. ☐

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Date of the actual completion of the international search	Date of mailing of the international search report
07 October 2008 (07.10.2008)	16 OCT 2008
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